

Service Manual #32



4.3L TKS
4.3L MPI
Gasoline Engines
(non-catalyst)



4.3L TKS Alpha/Bravo Serial Number 0M615000 and Above
4.3L MPI Alpha/Bravo Serial Number 0M300000 and Above

Models Covered

4.3 TKS

Models Covered	Serial Number
4.3 TKS Alpha	OM615000 and above
4.3 TKS Bravo	OM615000 and above

4.3 MPI

Models Covered	Serial Number
4.3 MPI Alpha	OM300000 and above
4.3 MPI Bravo	OM300000 and above

Notice to Users of This Manual

Throughout this publication, safety alerts labeled DANGER, WARNING, and CAUTION (accompanied by the international

hazard symbol ) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe these alerts carefully.

These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus common sense operation, are major accident prevention measures.

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Additional alerts provide information that requires special attention:

NOTICE

Indicates a situation which, if not avoided, could result in engine or major component failure.

IMPORTANT: Indicates information essential to the successful completion of the task.

NOTE: Indicates information that helps in the understanding of a particular step or action.

This manual has been written and published by the Mercury Marine Service Department to aid our dealers' mechanics and company service personnel when servicing the products described herein. It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury Marine power products, including the use of mechanics' common hand tools and the special Mercury Marine tools or recommended tools from other suppliers.

We could not possibly know of and advise the marine trade of all conceivable procedures and of the possible hazards and results of each method. Therefore, anyone who uses a service procedure or tool that is not recommended by the manufacturer must first completely satisfy himself that neither his nor the product's safety will be endangered.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products. We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins, operation, maintenance and warranty manuals, and installation manuals for other pertinent information concerning the products described in this manual.

Precautions

While working on the product, keep in mind that the electrical and ignition systems are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material into the cylinders, which could cause extensive internal damage when the engine is started.

During any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for reuse, care should be taken to select a replacement that matches the original.

Personnel should not work on or under an engine that is suspended. Engines should be attached to workstands, or lowered to the ground as soon as possible.

Replacement Parts

Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result.

WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

Cleanliness and Care of Product

A Mercury Marine power product is a combination of many machined, honed, polished, and lapped surfaces with tight tolerances. When any product component is serviced, care and cleanliness are important. It should be understood that proper cleaning and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

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Important Information

1

Removal and Installation

2

Engine

3

Electrical System

4

Fuel System

5

Cooling System

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Exhaust System

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Steering Systems

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Important Information

Section 1A - General Information

**1
A**

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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Stainless steel fasteners	92-802859A 1

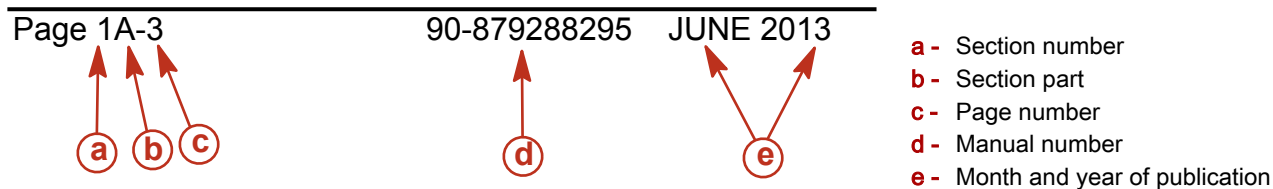
Introduction

This overhaul and repair manual is intended as a comprehensive service guide for the models listed in the **Models Covered** table at the beginning of this manual. It provides specific information, including procedures for disassembly, inspection, assembly, and adjustment, to enable dealers and service mechanics to repair these products.

Before attempting repairs we suggest that the procedure first be read in its entirety to gain knowledge of the methods and tools used and of the cautions and warnings required for safety.

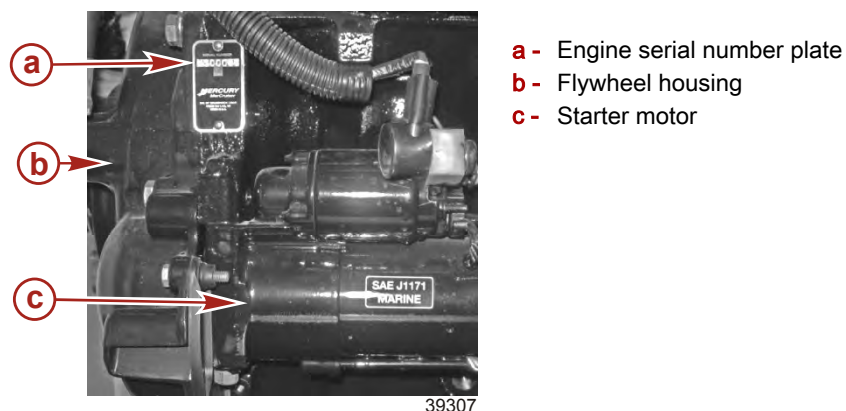
Service Manual Page Identification

The service manual part number, section, and page number appear at the bottom of the page. The section title appears at the top of the page.



18407

Engine Serial Number Locations



39307

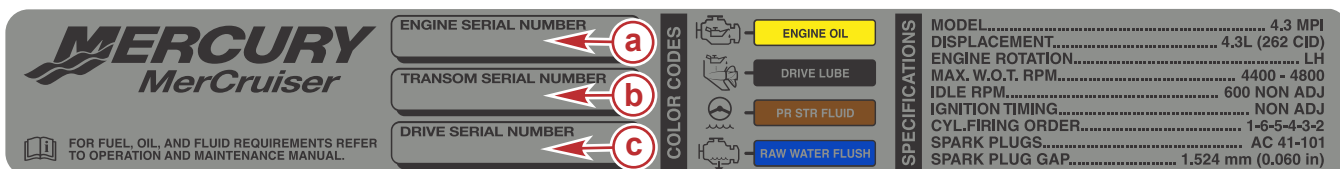
Serial Number Decal Location

There are two sets of engine, transom assembly, and sterndrive serial number decal strips provided with each power package. One should be used for each of the following:

- Engine specification decal
- Operation, maintenance and warranty manual identification page

Affix the engine, transom, and drive serial number decal strips to the specification decal located on the engine cover (MPI models), or carburetor cover (TKS models).

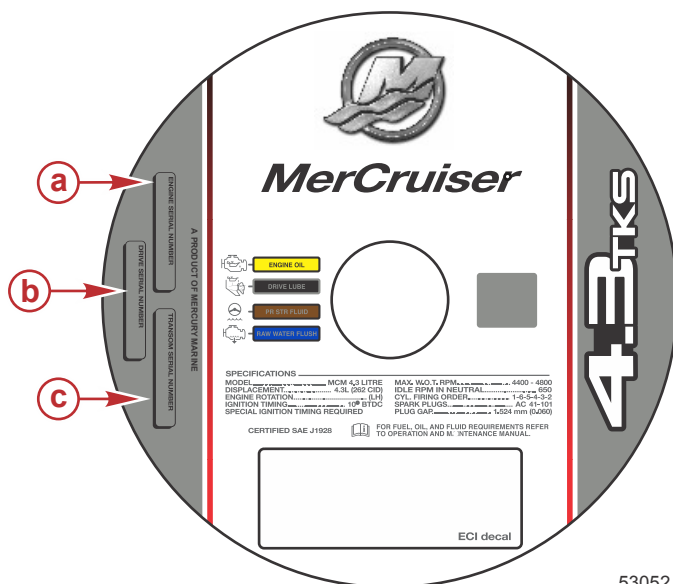
4.3 MPI Models



52317

- a - Engine serial number
- b - Transom serial number
- c - Drive serial number

4.3 TKS Models



53052

Carburetor cover decal

- a - Engine serial number
- b - Drive serial number
- c - Transom serial number

Directional References

All directional references in this document follow traditional nautical convention:

- The bow is the front of the boat. The stern is the rear of the boat.
- Fore means toward the bow. Aft means toward the stern.
- Starboard is the right-hand side of the boat as one faces forward.
- Port is the left-hand side of the boat as one faces forward.

MerCruiser Color Wiring Diagrams

Large scale, oversized color wiring diagrams are available in the MerCruiser diagram binder. The MerCruiser diagram binder was initially delivered to MerCruiser authorized repair facilities in June and July of 2007. As new diagrams are developed, they are distributed along with a revised, comprehensive index for addition to an existing binder.

Some features of the MerCruiser diagram binder are:

- An index in the binder identifies the diagrams by harness number, engine group and drive, and engine size and type.
- The diagrams are printed on an extremely durable, coated synthetic paper that can be wiped clean of grease and oil after use.
- The larger diagrams are easier to read. The diagrams come in two sizes, depending on the complexity of the related harness.
- Removable pages are easier to reference and allow the technician to take only the required diagram to a repair site instead of a complete service manual.
- Dry erase markers can be used directly on the diagrams for tracing circuits or for training. They wipe clean after use.
- Harness number headings make the drawings easy to find. The accompanying MerCruiser diagram binder index speeds lookup when the harness number is not known.

General Information

For information about ordering additional copies of the MerCruiser diagram binder or binder updates:

- MerCruiser authorized dealers, repair centers, or OEMs can order service literature on MercNET.
- Consumers can order service literature through the Mercury Dock Store (www.mercurydockstore.com), by contacting Mercury MerCruiser publications at 920-929-5110, or by contacting their local MerCruiser authorized dealer or repair center.

SeaCore

SeaCore Components and Castings

Mercury MerCruiser SeaCore power packages are equipped with additional stainless steel components and particular aluminum castings with special coatings. Do not replace SeaCore components with non-SeaCore. Use only the specified Mercury MerCruiser SeaCore components and castings on these power packages.

Stainless Steel Fasteners

SeaCore models are equipped with additional stainless steel fasteners to maximize corrosion resistance in saltwater environments.

Stainless steel fasteners are subject to galling when installed without lubrication. Galling can result in fastener destruction, improper clamp loads, or both. Galled fasteners may appear to tighten properly, but still have incorrect clamp loads.

Apply a lubricant, such as 2-4-C Marine Grease or an equivalent, on the threads of stainless steel fasteners during installation to avoid galling. Lubricate at least the first 6 mm (1/4 in.) of the threads before installation.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Stainless steel fasteners	92-802859A 1

SeaCore System

The SeaCore system is a complete engine sterndrive package. The SeaCore engine and sterndrive enhancements are:

- Hardcoat anodized external castings
- Additional stainless steel fasteners and hardware
- Closed cooling on the engine
- Freshwater flush system—flushes the entire system
- SmartCraft Engine Guardian
- Through-the-propeller exhaust
- Power Trim XD
- Compatible with 87 octane fuel

The SeaCore system provides corrosion protection for the engine with these standard features:

- Closed-cooling system with 5-year, long-life coolant
- Stainless steel steering shaft
- Stainless steel engine motor mounts and fasteners
- Dry-joint exhaust
- MerCathode corrosion protection system

The following stainless steel fasteners and hardware are used on this engine and sterndrive package for increased corrosion resistance:

- Gimbal housing studs
- Power steering hose—high pressure end
- Flywheel housing bolts
- Pulley attaching bolts and all engine component fasteners
- Engine mount stud and fastener

The SeaCore System provides corrosion protection for the sterndrive with the following standard features:

- Industrial hardcoat anodized XK360 aluminum drive housings and transom components

NOTE: Hardcoat anodizing is more abrasion resistant than case-hardened steel, and if the drive is scratched, the anodizing slows the destructive growth of corrosion through the drive surface.

- Protected interior passages
- Nonconductive surface to reduce galvanic corrosion
- Stainless steel sterndrive and transom fasteners

- Bravo III stainless steel bearing carrier
- Stainless steel upper swivel shaft (and new shaft seal) on the transom

Proper Break-In

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 RPM for extended periods of time for the first 10 hours. Shift into gear as soon as possible after starting and advance the throttle above 1500 RPM if conditions permit safe operation.
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during the first 10 hours. During the next 10 hours, occasional operation at full throttle is permissible (five minutes at a time maximum).
- Avoid full throttle acceleration from idle speed.
- Do not operate at full throttle until the engine reaches normal operating temperature.
- Frequently check engine oil level. Add oil as needed. It is normal for oil consumption to be high during the break-in period.

After the Break-In Period

The following recommendations should be considered to help extend the life of your Mercury MerCruiser power package:

- Ensure that the propeller allows the engine to operate at or near the top of the specified WOT (wide-open throttle) RPM range (refer to **Section 1C - Maintenance**) when at full throttle with a normal boat load.
- Operate the engine at 3/4 throttle or lower. Refrain from prolonged operation at WOT RPM.
- Change the engine oil and oil filter. Refer to **Section 1C - Maintenance**.

Fuel Requirements

IMPORTANT: Use of improper gasoline can damage your engine. Engine damage resulting from the use of improper gasoline is considered misuse of the engine and will not be covered under the Limited Warranty.

Fuel Ratings

Mercury MerCruiser engines will operate satisfactorily with any major brand of unleaded gasoline that meets the following specifications:

USA and Canada—A posted pump octane rating of 87 (R+M)/2, minimum, for all models. **Do not** use leaded gasoline.

Outside USA and Canada—A posted pump octane rating of 91 RON, minimum, for all models. Premium gasoline (98 RON) is also acceptable for all models. **Do not** use leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and is acceptable for use in your Mercury MerCruiser engine. The two types of oxygenates used in these fuels are alcohol (ethanol) and ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasoline Containing Alcohol**.

Gasoline Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), be aware of possible adverse effects. These adverse effects are more severe with methanol and worsen according to the percentage of alcohol in the fuel. Alcohol in gasoline can absorb moisture from the air, causing the water and the alcohol to separate from the gasoline in the fuel tank.

IMPORTANT: The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Starting and operating difficulties

⚠ WARNING

Fuel leakage is a fire or explosion hazard, which can cause serious injury or death. Periodically inspect all fuel system components for leaks, softening, hardening, swelling, or corrosion, particularly after storage. Any sign of leakage or deterioration requires replacement before further engine operation.

IMPORTANT: If you use gasoline that contains or might contain alcohol, you must increase the frequency of inspection for leaks and abnormalities.

IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, do not store the gasoline in the fuel tank for long periods. Cars normally consume alcohol-blend fuels before they can absorb enough moisture to cause trouble, boats often sit idle long enough for phase separation to take place. Internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Engine Oil

For optimum engine performance and maximum protection, use the following oil:

Application	Recommended Oil
All MerCruiser engines	Mercury/Quicksilver 25W-40 Synthetic Blend Engine Oil, NMMA FC-W Catalyst Compatible rated

IMPORTANT: Lubrication requirements for catalyzed engines differ from the requirements for noncatalyzed engines. Some marine-grade lubricants contain high levels of phosphorus. Although these high-phosphorus lubricants may allow acceptable engine performance, exposure over time will damage the catalyst. Catalysts damaged by lubricants containing high levels of phosphorus may not be covered by the MerCruiser Limited Warranty.

If Mercury/Quicksilver 25W-40 Synthetic Blend Engine Oil is unavailable, use the following lubricants, listed in order of recommendation.

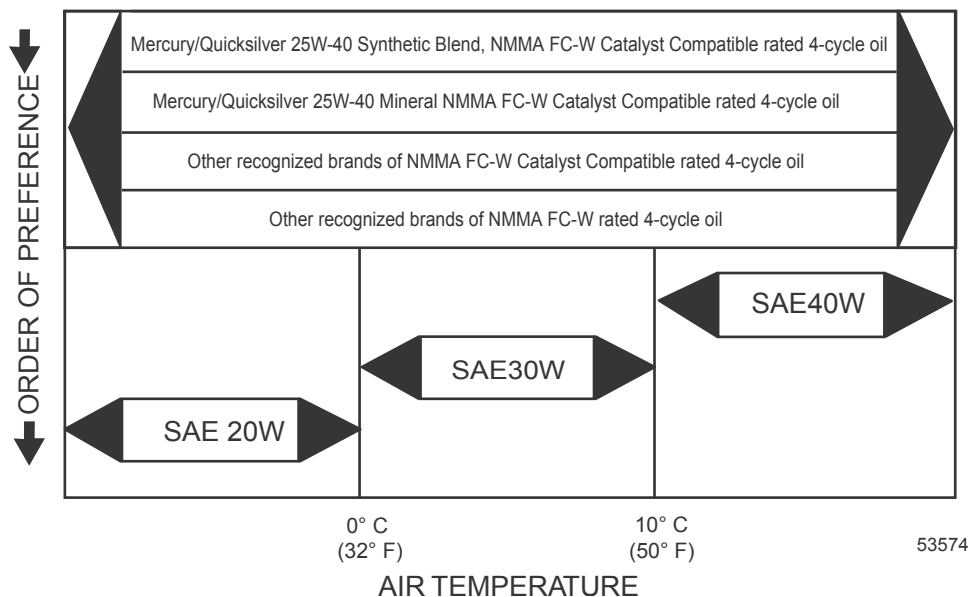
1. Mercury/Quicksilver 25W-40 Mineral NMMA FC-W Catalyst Compatible.

IMPORTANT: If you are servicing a catalyst engine, use the following oils for short periods of time only.

2. Other recognized brands of NMMA FC-W Catalyst Compatible rated 4-cycle oil.
3. Other recognized brands of NMMA FC-W rated 4-cycle oils.
4. A good-grade, straight-weight detergent automotive oil according to the last row of the operating chart below.

NOTE: We do not recommend nondetergent oils, multi-viscosity oils (other than as specified), non-FC-W rated synthetic oils, low-quality oils, or oils that contain solid additives.

Use the following information for selecting the type of oil according to the order of preference.



Important Information

Section 1B - Emissions Control



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Emissions Regulations

International Regulations Compliance

MerCruiser products are designed and manufactured to meet the host of regulatory requirements set forth by the following standards and regulatory organizations:

- ABYC (American Boat and Yacht Council)
- USCG (United States Coast Guard)
- SAE (Society of Automotive Engineers)
- ISO (International Standards Organization)
- CARB (California Air Resources Board)
- EU (European Union)
- SAV (Schweizer Abgas Vorschriften—Swiss Gas Regulations)
- JCI (Japan Craft Inspection Organization)

California Regulations for 2007—Low-Permeation Fuel Hose

California regulations mandate that any spark-ignition inboard/sterndrive pleasurecraft manufactured in 2007 or later and sold in the state of California use low-permeation fuel line hose for the primary fuel line connecting the fuel tank to the engine of said boat. For full details, refer to (2007) 13 C.C.R. §2442(b).

Low-permeation fuel line hose is USCG Type A1-15, defined as not exceeding 15 g/m²/24 h with CE10 fuel at 23° C as specified in SAE J 1527—Marine Fuel Hoses.

Emissions Information on the Product

Emission Control Information Label

NOTE: If a part with emission control information is removed, a new decal must be ordered and installed on the new part.

A tamper-resistant emission control information label is affixed to the engine in a visible location at time of manufacture by Mercury MerCruiser. In addition to the required emissions statement, the label lists:

- Engine serial number ("SERIAL#")
- Engine family ("FAMILY")
- Engine family emission limit ("FEL.")
- Date (month and year) of manufacture ("D.O.M")
- Engine displacement, in liters ("DISP")

Note that the low emissions certification will not affect the fit, function, or performance of the engines. Boatbuilders and dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding.

		EMISSION CONTROL INFORMATION	
THIS ENGINE CONFORMS TO 2003 CALIFORNIA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES REFER TO OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS			
SERIAL#	OMXXXXXXXX	D.O.M	JAN. 2003
FAMILY	XXXXX XXXXXX	DISP	X.XL
FEL.	XX.X g/kW-hr		

11018

Emission control label—Non-CE marked

		EMISSION CONTROL INFORMATION	
THIS ENGINE CONFORMS TO 2003 CALIFORNIA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES			
REFER TO OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS			
SERIAL#	OMXXXXXX	D.O.M.	Dec 2004
FAMILY	XXXXXX XXXXXX		
FEL.	XX.X g/kW-hr	DISP.	X.XL
			 0575

10652

Emission control label—CE marked

CE: When this mark is present in the lower right corner of the Emission Control Information label on the engine, the Declaration of Conformance applies.

Emission Control Information Label Request Form

To obtain a decal request form, contact warranty registration at 920-929-5054.

Notes:

Important Information

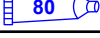
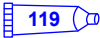
Section 1C - Maintenance

1 C

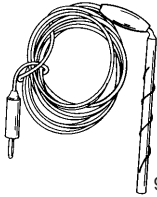
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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Gimbal bearing	8M0071842
		Driveshaft splines and U-joint O-rings	
		Coupler	
		Transom end grease fitting, engine end grease fitting, driveshaft grease fittings	
		Propeller shaft	
 7	Loctite 271 Threadlocker	Propeller shaft anode screw threads	92-809819
 25	Liquid Neoprene	All electrical connections	92- 25711 3
 80	SAE Engine Oil 30W	Water-separating fuel filter sealing ring	Obtain Locally
 87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01
 95	2-4-C with PTFE	Steering cable grease fitting	92-802859A 1
		Exposed part of steering cable	
		Propeller shaft	
 114	Power Trim and Steering Fluid	Power trim pump	92-858074K01
		Power-assisted steering system	
 115	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
 119	Storage Seal Rust Inhibitor	Carburetor	92-858081K03
 120	Corrosion Guard	Painted surfaces	92-802878 55
 124	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932
 139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Pivot points and the guide contact surfaces	92-858052K01

Special Tools

Belt Tension Gauge	SPX BT-33-73-F
 39451	Measures serpentine belt deflection.
Reference Electrode	91-76675T 1
 9188	Senses and electrical current in the water when testing the MerCathode system. Use to check hull potential.

Flushing Device	91-44357Q 2
 9192	Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine.
Dual Water Pick-up Flush Gearcase Seal Kit	91-881150K 1
 9194	Blocks off the front water inlet holes on the dual water inlet gearcases.
Flushing Kit	91-849996T 1
 9195	Use for flushing gearcases with low water inlets.

Engine Specifications

Notes on Engine Specifications

- Performance specifications are obtained and corrected in accordance with SAE J1228 (crankshaft power) and ISO 8665 (standard power).
- All measurements are taken with the engine at normal operating temperature.
- RPM range is measured using an accurate service tachometer with the engine at normal operating temperatures.
- Oil pressure must be checked with the engine at normal operating temperature.
- Oil pressure specifications are for reference and may vary.

IMPORTANT: Do not mix spark plug types in an engine. All spark plugs should have the same part number.

4.3L V6

Specification	4.3L TKS	4.3L MPI
Horsepower (performance obtained and corrected in accordance with SAE J1228)	190	220
Kilowatts (performance obtained and corrected in accordance with SAE J1228)	142	164
Displacement	4.3L (262 cid)	
Specified WOT RPM range (measured using an accurate service tachometer with the engine at normal operating temperatures)	4400–4800	4400–4800
Idle RPM in neutral (measured using an accurate service tachometer with the engine at normal operating temperatures)	600 (idle speed and timing on MPI models are not adjustable)	
Minimum oil pressure at idle (oil pressure must be checked with the engine at normal operating temperature)	55 kPa (4 psi)	
Minimum oil pressure at 2000 RPM (oil pressure must be checked with the engine at normal operating temperature)	124 kPa (18 psi)	
Thermostat	71° C (160° F)	
Thermostat (closed cooling)	76° C (170° F)	
Timing at idle (idle speed and timing on EFI models are not adjustable)	10° BTDC	Not adjustable
Firing order	1-6-5-4-3-2	
Electrical system	12 volt negative (–) ground	
Alternator rating (hot operating amps)	65 A	
Alternator rating (cold operating amps)	72 A	
Recommended battery rating for TKS models (minimum)	375 CCA, 475 MCA, or 90 Ah	
Recommended battery rating for MPI models (minimum)	750 CCA, 950 MCA, or 180 Ah	
Spark plug type	AC MR43LTS	NGK ITR4A15
Spark plug gap	1.14 mm (0.045 in.)	1.5 mm (0.060 in.)

Fluid Specifications

IMPORTANT: All capacities are approximate fluid measures.

Engine

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

Always use the dipstick to determine the exact quantity of oil or fluid required.

4.3L MPI and 4.3 TKS Models	Capacity	Fluid Type
Engine oil (with filter)	3.8 Liter (4 US qt)	Mercury/Quicksilver 25W-40 Synthetic Blend Engine Oil
Seawater cooling system (winterization use only)	20 Liter (21 US qt)	Propylene Glycol and Purified Water
Closed-cooling system	19 Liter (20 US qt)	Mercury Extended Life Coolant/Antifreeze or Extended Life Ethylene Glycol 5/100 Coolant/Antifreeze mixed 50/50 with Purified Water

Alpha Sterndrive

NOTE: Oil capacity includes gear lube monitor.

Model	Capacity	Fluid Type
Alpha One	1892 mL (64 oz)	High Performance Gear Lubricant

Bravo Sterndrives

NOTE: Oil capacity includes gear lube monitor.

Model	Capacity	Fluid Type
Bravo One	2736 mL (92-1/2 oz)	High Performance Gear Lubricant
Bravo Two	3209 mL (108-1/2 oz)	
Bravo Three	2972 mL (100-1/2 oz)	

Power-Assisted Steering and Power Trim Fluids

Approved Power-Assisted Steering Fluids

Description	Part Number
Power Trim and Steering Fluid	92-858074K01

Approved Power Trim Fluids

Description	Part Number
Power Trim and Steering Fluid	92-858074K01
SAE Engine Oil 10W-30	Obtain locally
SAE Engine Oil 10W-40	

Maintenance Schedules

Routine Maintenance

NOTE: Perform only the maintenance that applies to your particular power package.

Interval	Action
Each Day Start	- Check the engine oil level. This task interval can be extended based on operator experience with the product. - Check the coolant level. - Check the power-assisted steering fluid level. - Check the sterndrive gear lube level in the gear lube monitor. - Check the trim pump fluid level.
Each Day End	Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water.
Weekly	- Check the coolant level. - Check the trim pump fluid level. - Check the seawater inlets for debris or marine growth. - Check and clean the seawater strainer. - Inspect the sterndrive anodes, and replace them if 50% eroded.
Every Two Months or 50 Hours	- Lubricate the propeller shaft and tighten the nut to the specified torque (if operating in only freshwater, this maintenance may be extended to every four months). - Lubricate the engine coupler every 50 hours if operated at idle for prolonged periods of time. - Operating in saltwater or brackish or polluted water only: treat the power package with Corrosion Guard. - Check the battery connections and the fluid level. - Ensure that the gauges and the wiring connections are secure. Clean the gauges.¹

Scheduled Maintenance

NOTE: Only perform the maintenance that applies to your power package.

1. If operating in saltwater, interval is reduced to every 25 hours or 30 days whichever occurs first.

After the Initial 20-Hour Break-In Period

To help extend the life of your Mercury MerCruiser power package, we recommend the following:

- Change the engine oil and filter

Interval	Action
Every 100 Hours or Annually (Whichever Occurs First)	• Touch-up the paint on the power package. • Change the crankcase oil and filter. • Change the drive unit oil. • Tighten the gimbal ring U-bolt nuts to the specified torque. • Replace the water separating fuel filter element. • Clean or replace the IAC muffler (MPI models). • Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and the linkages. • Check the continuity circuit for loose or damaged connections. Test the MerCathode unit output on Bravo models. • Clean the flame arrestor. • Clean the crankcase ventilation hoses. • Inspect the condition and the tension of the belts. • Driveshaft extension models: Lubricate the driveshaft U-joints, and the tailstock input and output bearings. • Check the coolant level and antifreeze concentration (models with closed cooling).
Every 200 Hours or 3 Years	• Inspect the U-joints, the splines, and the bellows. Check the clamps. Check the engine alignment. Lubricate the U-joint splines and cross bearing, if equipped with a grease fitting. • Lubricate the gimbal bearing and the engine coupler. Lubricate the engine coupler every 50 hours if operated at idle for prolonged periods of time.
Every 300 Hours or 3 Years	• Check the engine mounts for tightness and retorquer if necessary. • Inspect the distributor cap, rotor, spark plugs, and spark plug wires. • Check the electrical system for loose, damaged, or corroded fasteners. • Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. • Disassemble and inspect the seawater pump and replace worn components. • Clean the seawater section of the closed cooling system. Clean, inspect, and test the pressure cap. • Inspect the exhaust system components and verify that the flapper valves are not missing or worn, if equipped. • Inspect the gimbal bearing for roughness. • Inspect the condition and the tension of the belts. • Inspect the U-joints, the splines, and the bellows. Check the clamps. Check the engine alignment. Lubricate the U-joint splines and cross bearing, if equipped with a grease fitting.
Every 5 Years	• Replace the coolant (every two years if extended life antifreeze coolant is not being used).

Maintenance Procedures

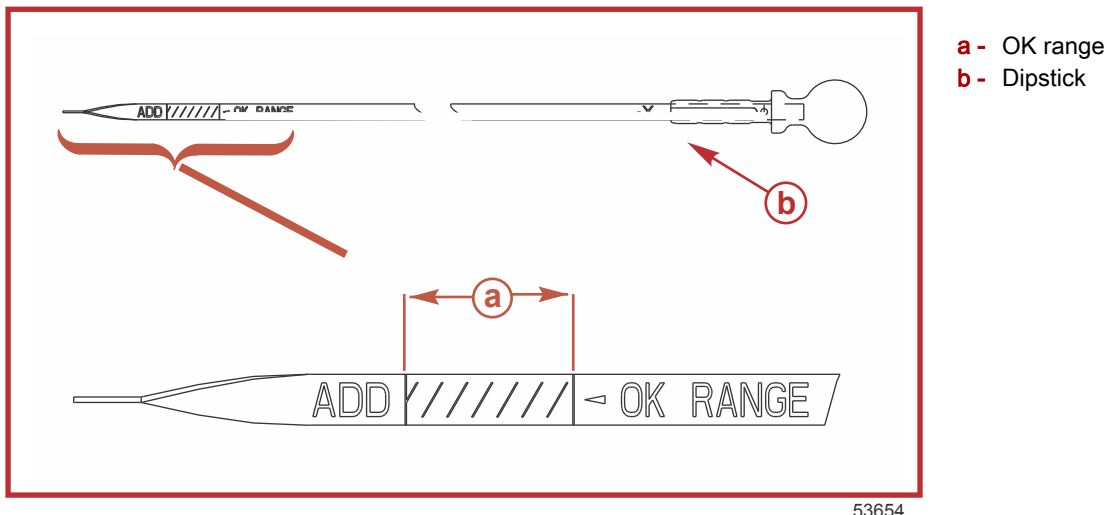
Engine Oil

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

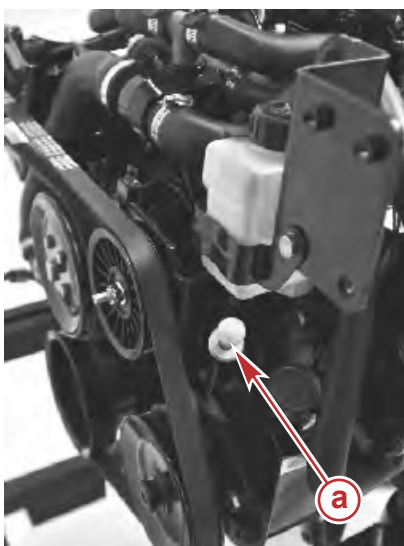
Oil Level—Overfilled

An overfilled crankcase (oil level too high) can cause a fluctuation or drop in oil pressure, and rocker arm clatter. This condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to bleed down. This, in turn, results in rocker arm clatter and loss of engine performance, due to the valves not opening properly. Care must be taken when checking the engine oil level. The oil level must be maintained between the "ADD" mark and the "FULL" or "OK RANGE" mark on the dipstick. To avoid getting a false reading, adhere to the following procedures.



Checking

1. Stop the engine. Allow approximately five minutes for the oil to drain into the oil pan. The boat must be at rest in the water.
2. Remove the dipstick. Wipe it clean and reinstall it fully into the dipstick tube. Wait 60 seconds to allow trapped air to vent.



IMPORTANT: Add the specified engine oil to bring the level up to, but not over, the full (OK RANGE) mark on the dipstick.

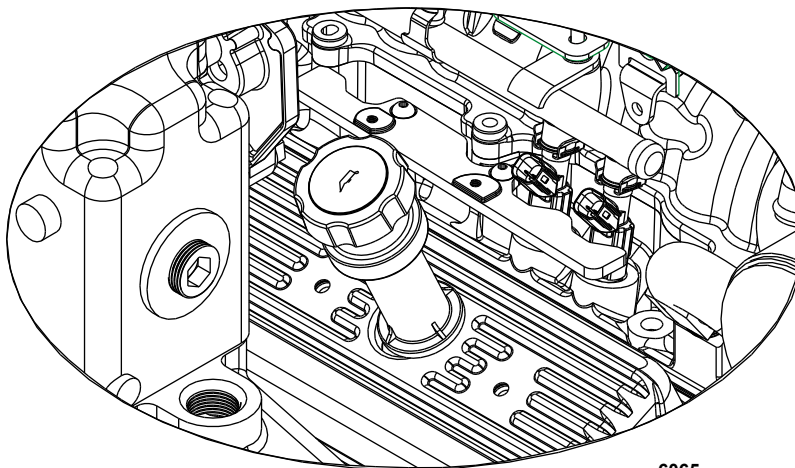
3. Remove the dipstick and observe the oil level. The oil level must be between the full (OK RANGE) and ADD marks on the dipstick. Reinstall the dipstick into the dipstick tube.

Filling

IMPORTANT: Do not overfill the engine with oil.

IMPORTANT: Always use the dipstick to determine the exact quantity of oil or fluid required.

1. Remove oil fill cap.



6065

IMPORTANT: Add the specified engine oil to bring the level up to, but not over, the full or OK RANGE mark on the dipstick.

2. Add the specified engine oil to bring the level up to, but not over, the full or OK RANGE mark on the dipstick. Recheck oil level.
3. Replace the fill cap.

Engine Model	Engine Oil Capacity	Fluid type
4.3L MPI (262 cid)	3.8 Liter (4 US qt)	Mercury/Quicksilver Synthetic Blend MerCruiser Engine Oil 25W-40
4.3L TKS (262 cid)	3.8 Liter (4 US qt)	Mercury/Quicksilver Synthetic Blend MerCruiser Engine Oil 25W-40

Changing Oil and Filter

Refer to the maintenance schedule for the change interval. Engine oil should be changed before placing the boat in storage.

IMPORTANT: Change the engine oil when the engine is near operating temperature. Warm oil flows more freely, carrying away more impurities. Use only recommended engine oil (refer to Specifications).

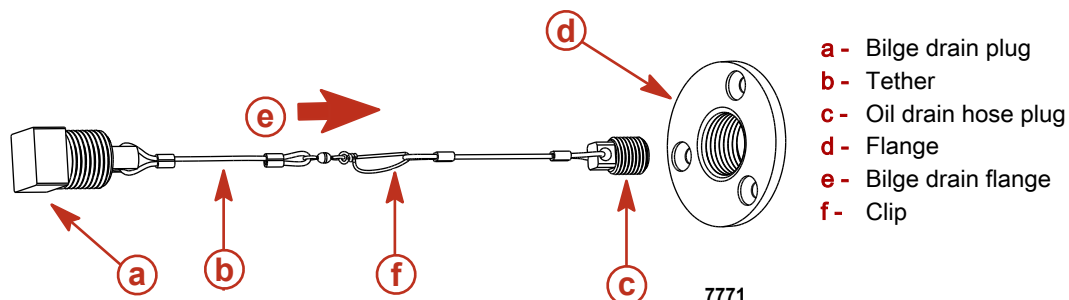
Easy Engine Oil Drain System

NOTE: Boat must be out of water to perform this procedure.

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

1. Place a cloth or suitable container below the oil filter and loosen the filter to vent the system.

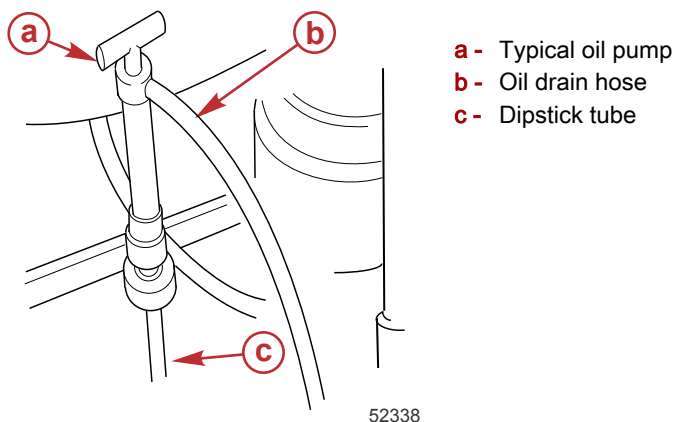


7771

2. Remove the bilge drain plug.
3. Pull the tether through the bilge drain.
4. Place the oil drain hose into a suitable container.
5. Remove the drain plug from the oil drain hose.
6. After the oil has drained completely, install the drain plug in the oil drain hose.
7. Push the hose through the bilge drain, and install the plug.

Engine Oil Drain Pump

1. Place an oil absorbent cloth below the oil filter, and loosen the filter to vent the system (models equipped with a remote oil filter).
2. Remove the dipstick.
3. Install the oil pump onto the dipstick tube.

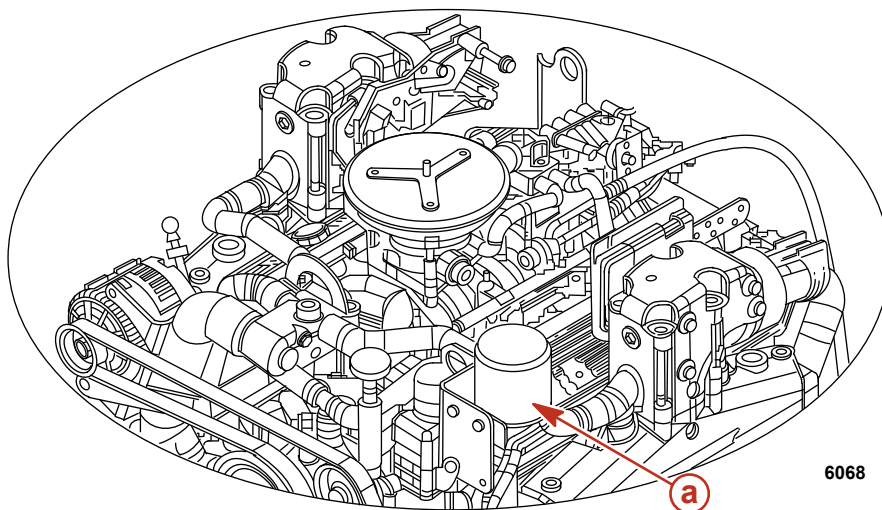


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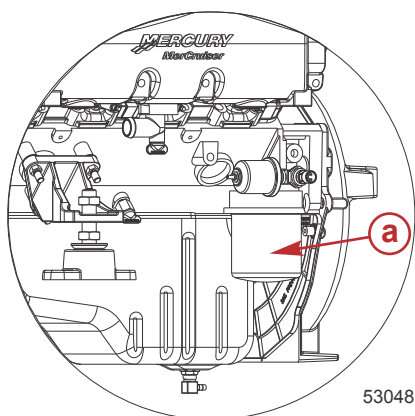
4. Insert the hose end of the crankcase oil pump into an appropriate container and, using the handle, pump until the crankcase is empty.
5. Remove the pump.
6. Install the dipstick.

Changing Filter

1. Place an oil absorbent cloth below the oil filter.
2. Remove and discard the oil filter.



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53048

3. Coat the sealing ring on the new filter with engine oil, and install it.
4. Tighten the oil filter securely following the filter manufacturer's instructions. Do not overtighten.
5. Remove the oil fill cap.
IMPORTANT: Always use the dipstick to determine exactly how much oil is required.
6. Add recommended engine oil to bring level up to the bottom of the OK RANGE on the dipstick.
7. With the boat at rest in the water, check the oil level and add the specified fluid to bring the oil level up to, but not over, the full (OK RANGE) mark.

Engine Model	Engine Oil Capacity	Fluid Type
4.3L MPI	3.8 Liter (4 US qt)	Mercury/Quicksilver Synthetic Blend MerCruiser Engine Oil 25W-40
4.3L TKS	3.8 Liter (4 US qt)	Mercury/Quicksilver Synthetic Blend MerCruiser Engine Oil 25W-40

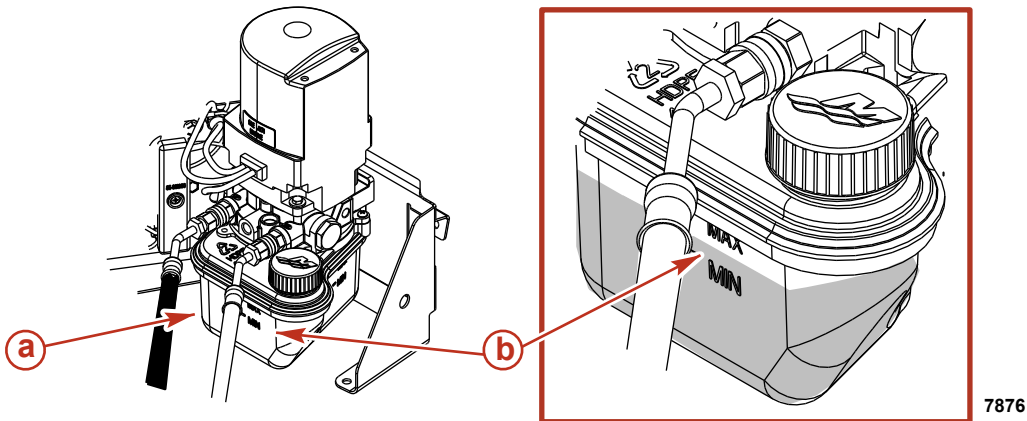
8. Start the engine, run the engine for three minutes, and check for leaks. Stop the engine. Allow approximately five minutes for the oil to drain into the oil pan. The boat must be at rest in the water.

Power Trim Fluid

Checking

IMPORTANT: Check the oil level with the sterndrive unit in the full down/in position only.

1. Place the sterndrive unit in full down/in position.
2. Observe the oil level. Level must be between the "MIN" and "MAX" lines on the reservoir.



- a** - Reservoir
- b** - "MIN" and "MAX" lines

3. Fill as necessary with the specified fluid.

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power trim pump	92-858074K01

Filling

1. Remove the fill cap from the reservoir.
NOTE: Fill cap is vented.
2. Add lubricant to bring level to the within the "MIN" and "MAX" lines on the reservoir.

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power trim pump	92-858074K01

3. Install the cap.

Changing

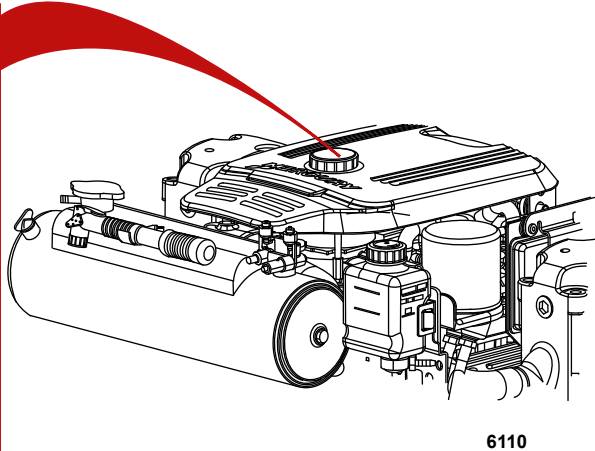
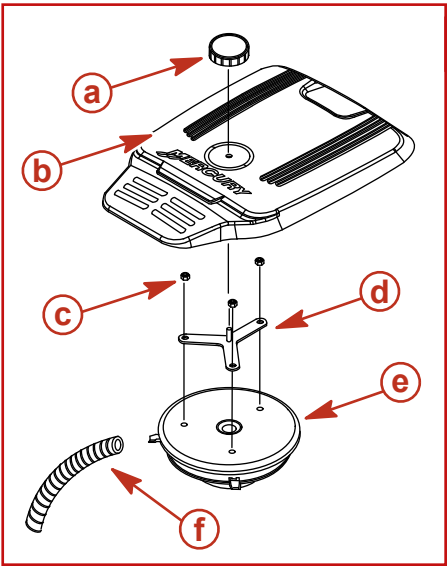
Power trim fluid does not require changing unless it becomes contaminated with water or debris. Contact your authorized Mercury MerCruiser dealer.

Cleaning the Flame Arrestor

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. Remove the engine cover.
2. Disconnect and remove the crankcase ventilation hose from the fitting on the flame arrestor and valve cover.
3. Remove the flame arrestor.



- a - Engine cover knob
- b - Engine cover
- c - Flame arrestor nuts
- d - Cover mount bracket
- e - Flame arrestor
- f - Crankcase ventilation hose

4. Clean the flame arrestor with warm water and a mild detergent.
5. Inspect the flame arrestor for holes, cracks, or deterioration. Replace it if necessary.
6. Allow the flame arrestor to air-dry completely before use.
7. Clean the crankcase ventilation hose with warm water and a mild detergent. Dry with compressed air or allow to air dry completely.
8. Inspect the crankcase ventilation hose for cracks or deterioration. Replace it if necessary.
9. Clean or replace the IAC muffler (MPI models).
10. Install the flame arrestor and flame arrestor bracket. Tighten the flame arrestor bracket nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Flame arrestor bracket nut	12	106	–

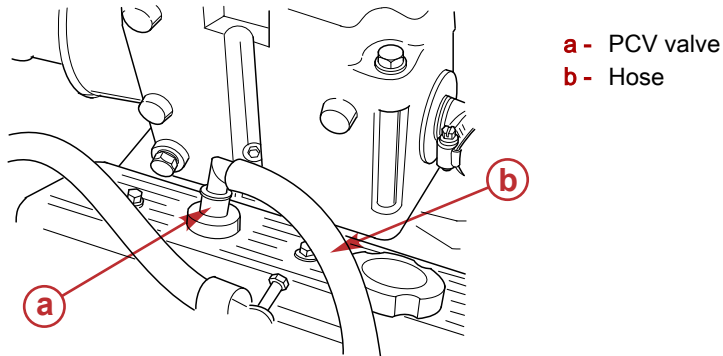
11. Connect the crankcase ventilation hose to the fitting on the flame arrestor and valve cover.
12. Install the engine cover.

Positive Crankcase Ventilation (PCV) Valve

Changing

NOTE: We recommend the use of Mercury MerCruiser replacement parts to ensure compliance with emission regulations.

1. Remove the PCV valve from the port valve cover.

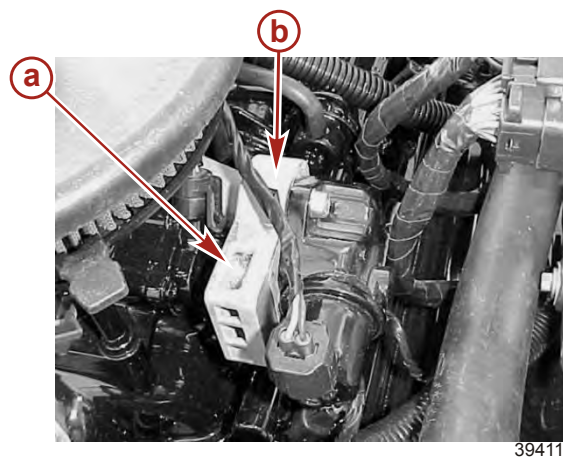


2. Disconnect the PCV valve from the hose, and discard the valve.
3. Install a new PCV valve in the valve cover, and reconnect the hose.
4. Ensure that the PCV valve is tightly seated in the valve cover.

IAC Muffler—MPI Models

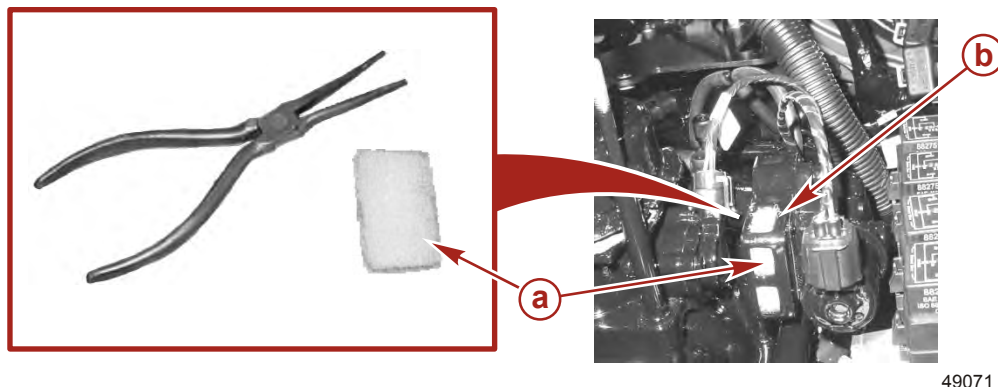
Removal

1. Remove the engine cover.
2. Locate the IAC adapter manifold and muffler.



IAC muffler in adapter manifold—typical engine

3. Remove the IAC muffler from the slot in the adapter using needle-nose pliers. Note the orientation of the muffler in the slot.

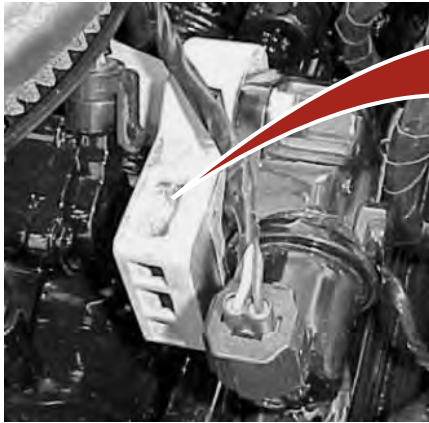


Cleaning and Inspection

1. Inspect the IAC muffler for holes, cracks, or deterioration. Replace the IAC muffler if damaged.
2. Clean the muffler with warm water and mild detergent.
3. Allow the muffler to air-dry completely before use.

Installation

1. Using needle-nose pliers, insert the IAC muffler in the slot of the adapter at the same orientation as noted during removal.

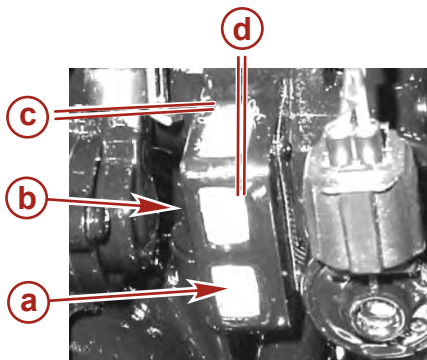


IAC muffler in adapter manifold—typical engine

- a** - Needle-nose pliers
- b** - IAC muffler in adapter slot

49089

2. To avoid unwanted noise such as whistling, ensure that no gaps exist between the muffler and any openings in the housing's air intake.



- a** - IAC muffler
- b** - Housing
- c** - No gap—horizontally
- d** - No gap—vertically

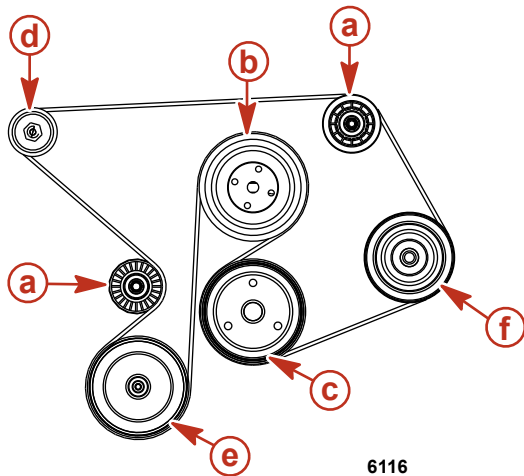
49070

3. Install the engine cover. Tighten the knob securely.

Serpentine Drive Belt

⚠ WARNING

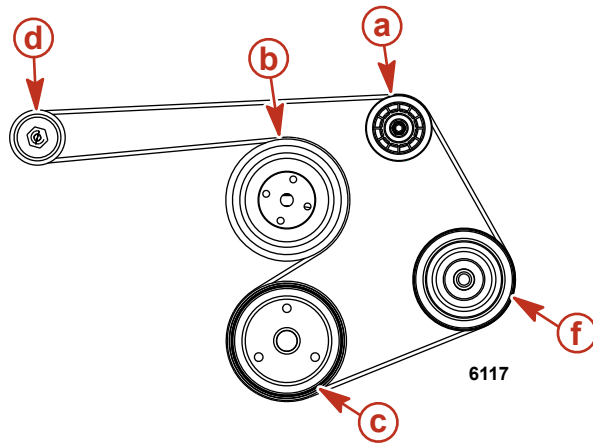
Inspecting the belts with the engine running may cause serious injury or death. Turn off the engine and remove the ignition key before inspecting the belts.



6116

With a seawater pump

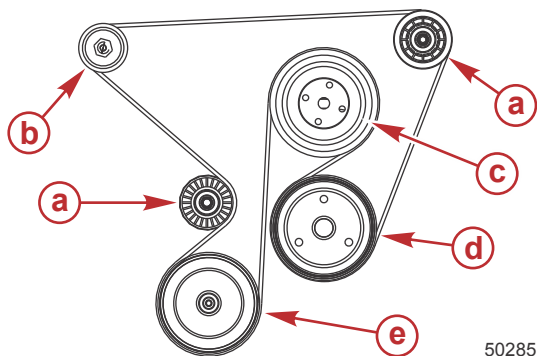
- a - Idler pulley
- b - Water circulating pump pulley
- c - Crankshaft pulley
- d - Alternator pulley
- e - Seawater pump pulley
- f - Power steering pump pulley



6117

Without a seawater pump

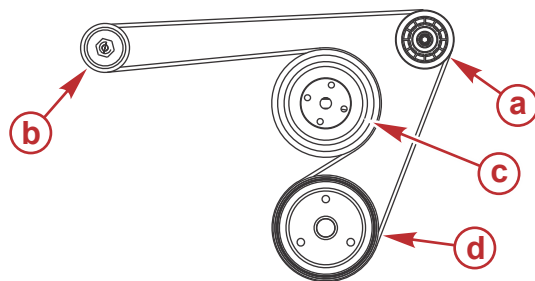
Second Engine on a Dual Engine Installation



50285

With a seawater pump and without a power steering pump

- a - Idler pulley
- b - Alternator pulley
- c - Water circulating pump pulley
- d - Crankshaft pulley
- e - Seawater pump pulley



50286

Without a seawater pump and without a power steering pump

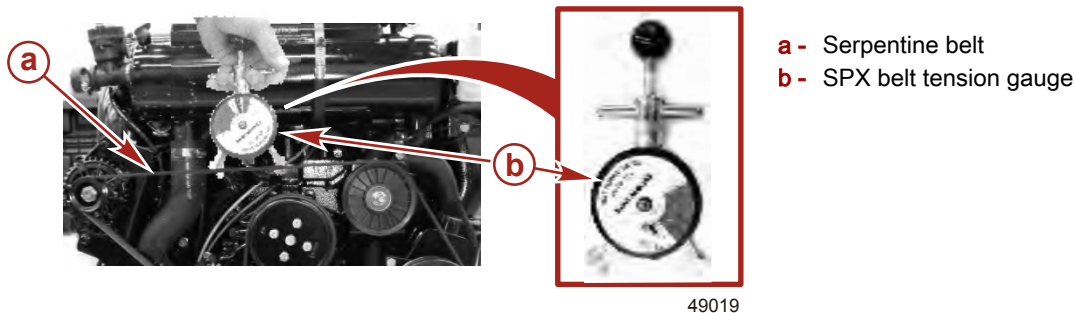
Replacing Belt or Adjusting Tension

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

NOTE: Belt deflection is to be measured on the belt at the location that has the longest distance between two pulleys.

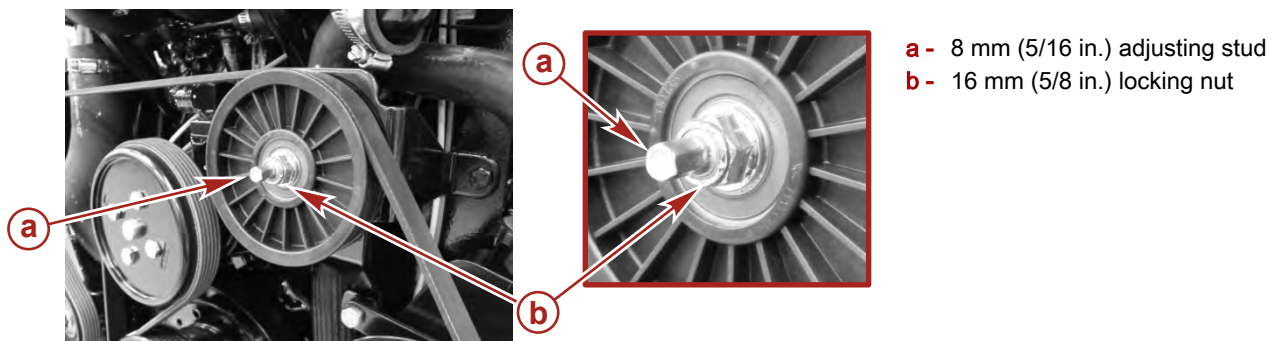
1. Loosen the 16 mm (5/8 in.) locking nut on the adjustment stud.
2. Turn the adjustment stud and loosen the belt.
3. If a new serpentine drive belt is required, remove the old belt, and install a new belt onto the pulleys.

4. Put a wrench on the adjustment stud 16 mm (5/8 in.) locking nut.
5. Use an 8 mm (5/16 in.) socket and tighten the adjusting stud to adjust the belt deflection.
6. Using one of the two methods following, check for correct deflection.
 - a. Push down with moderate thumb pressure on the longest stretch of belt. Proper deflection is 13 mm (½ in.).
 - b. Attach the belt tension gauge to the belt. The gauge has different ranges for new and used belts.



Belt Tension Gauge	SPX BT-33-73-F
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7. While holding the adjustment stud at the correct belt tension, tighten the 16 mm (5/8 in.) locking nut to the specified torque.



Description	Nm	lb-in.	lb-ft
Locking nut	29	–	21

8. Operate the engine for a short period of time and recheck the belt adjustment.

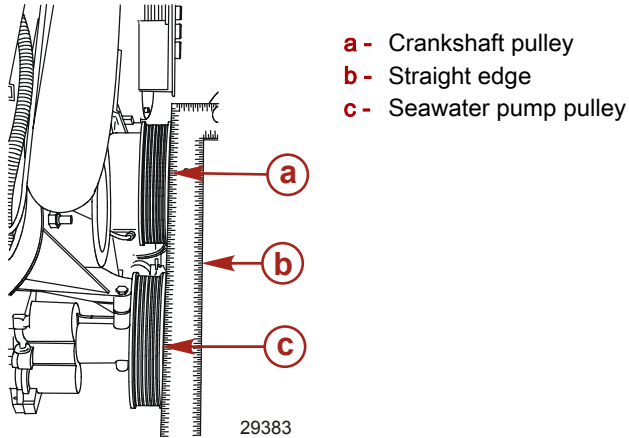
Pulley Alignment

Premature belt failure is an indication of pulley misalignment or pulley damage. Care must be taken when removing or installing an engine to prevent damage to engine components, brackets, or pulleys. Pulleys that are misaligned due to bent or damaged brackets can cause belt shredding and premature failure. Stepping on pulleys and belt driven components that are mounted on brackets can cause pulley misalignment and subsequent belt failure.

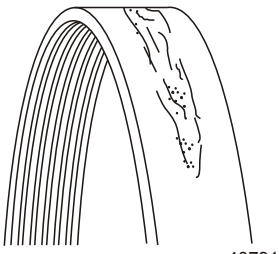
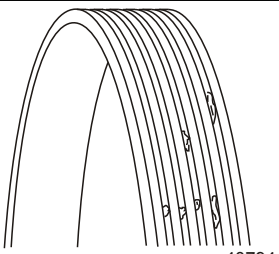
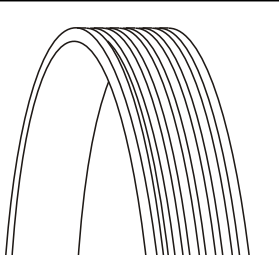
Verifying Pulley Alignment

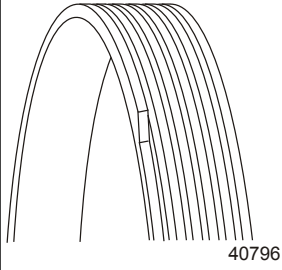
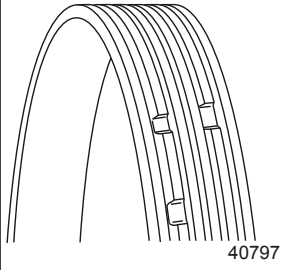
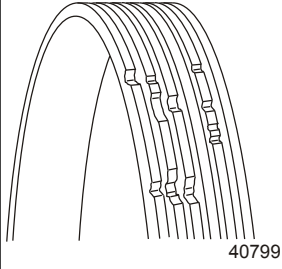
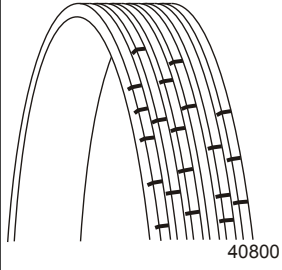
1. Place the straight edge across the seawater pump, alternator, or power steering pump pulley and the crankshaft pulley.

2. Compare the angle of the outer face of each pulley to the straight edge. It should be parallel. The outer face of the seawater pump pulley may be slightly in front of or behind the straight edge.



Serpentine Belt Failure Identification

Appearance	Description	Cause	Solution
 40791	Abrasion Each side of the belt appears shiny or glazed. Severe condition: Fabric is exposed.	Belt is in contact with an object. Can be caused by improper belt tension or tensioner failure.	Replace the belt and inspect for contact with an object. Verify the belt tensioner is functioning.
 40794	Pilling Belt material is sheared off from the ribs and builds up in the belt grooves.	There are a number of causes including lack of tension, misalignment, worn pulleys, or a combination of these factors.	When pilling leads to belt noise or excess vibration, the belt should be replaced.
 40795	Improper install The belt ribs begin separating from the joined strands. If left unattended, the cover will often separate, causing the belt to unravel.	Improper belt installation is a common cause of premature failure. One of the outermost belt ribs is placed outside the pulley groove, causing a belt rib to run without a supporting or aligning pulley groove.	The belt life has been severely limited and should be replaced immediately. Ensure all ribs of the replacement belt fit into the pulley grooves. Run the engine. Then, with the engine off and battery disconnected, inspect the belt for proper installation.

Appearance	Description	Cause	Solution
 40796	Misalignment Sidewalls of the belt may appear glazed or the edge-cord may become frayed and the ribs are removed. A noticeable noise may result. In severe cases, the belt can jump off the pulley.	Pulley misalignment. Misalignment forces the belt to kink or twist while running, causing premature wear.	Replace the belt and verify the alignment of the pulley.
 40797	Chunk-out Pieces or chunks of rubber material have broken off the belt. When chunk-out has occurred, a belt can fail at any moment.	Chunk-out can happen when several cracks in one area move parallel to the cord line. Heat, age, and stress are the primary contributors.	Replace the belt immediately.
 40799	Uneven rib wear Belt shows damage to the side with the possibility of breaks in the tensile cord or jagged edged ribs.	A foreign object in the pulley can cause uneven wear and cut into the belt.	Replace the belt and inspect all pulleys for foreign objects or damage.
 40800	Cracking Small visible cracks along the length of a rib or ribs.	Continuous exposure to high temperatures, the stress of bending around the pulley leads to cracking. Cracks begin on the ribs and grow into the cord line. If three or more cracks appear in a three-inch section of a belt, eighty percent of the life is gone.	Replace the belt immediately.

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in the direction of belt length) that join transverse cracks are NOT acceptable.

Closed Cooling

Description

Closed cooling is a standard feature on some models and is available as an accessory or a factory installed option on others. When closed cooling is used, a mixture of antifreeze and water is circulated through the water jackets in the engine block, cylinder heads, and—on some applications—the exhaust manifolds to dissipate the heat. Refer to Water Flow Diagrams. This coolant is then passed through a heat exchanger. Here the coolant rejects heat to seawater (water in which the boat is being operated), which is simultaneously being passed through the exchanger. The heat is then carried away by the seawater and discharged overboard via the exhaust elbows. The design of the heat exchanger allows for the transfer of heat, while ensuring that the two coolants are separated. In this manner, the expensive engine components are never exposed to seawater, which can be corrosive in salty, polluted, or mineral laden water areas.

Mercury MerCruiser's closed cooling systems are developed by the same people who design our engines to ensure compatibility and the same high quality standards. Our systems employ several exclusive features to provide unsurpassed cooling efficiency and durability. An exclusive double-acting thermostat is used on V6 and V8 models, which provides increased coolant velocity through the engine and heat exchanger to prevent hot spots and improve performance. Mercury MerCruiser's heat exchangers also incorporate several state-of-the-art designs to enhance the heat transfer between the coolants for an additional margin of cooling capacity. Features like these allow our systems to continually operate at WOT in water temperatures up to 38 °C (100 °F), where most after-market systems fall short of this mark. This additional cooling capacity translates into longer cooling system life with fewer problems regardless of where the boat is operated. Contact your sales representative to order your closed cooling systems factory installed or refer to the Mercury Precision Parts and Accessories Guide to obtain the part numbers for the accessory kits.

The term full closed cooling, also known as full fresh water cooled or full FWC refers to the use of an ethylene glycol mixture in the engine and the exhaust water jackets. The ethylene glycol coolant mixture is circulated through the exhaust cooling passages as well as the engine cooling passages.

Antifreeze Recommendations

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Factory installed closed cooling systems come filled with an Extended Life Antifreeze. This coolant allows for a service interval of 5 years or 1000 hours (whichever occurs first), versus 2 years or 400 hours for standard antifreeze. When adding coolant to these systems (i.e. when filling coolant recovery bottle, installing hot water heater), we recommend that only an Extended Life Antifreeze be used. Mixing this coolant with even a small amount of regular antifreeze will require that the service interval be reduced 2 years. If you are installing closed cooling kits at your facility, we would also encourage you to use the Extended Life Coolant to allow your customer to take advantage of the reduced maintenance costs.

Premixed Extended Life Coolant is available from Quicksilver or can be purchased at most automotive stores and other locations where antifreeze is sold. Extended Life Coolant is available from Texaco under the name Havoline Extended Life Dex Cool. Prestone also offers a version of this antifreeze called Extended Life 5/100. Only coolants that state that they are compatible with Dex Cool should be used. Extended Life Coolants can be identified by their orange color (versus green for standard coolant) and their corresponding orange cap on the container.

All antifreeze should be mixed 50/50 with pure water (Quicksilver coolant is already premixed). If installing closed cooling kits at your facility, be sure to observe the special filling procedure in the installation instructions.

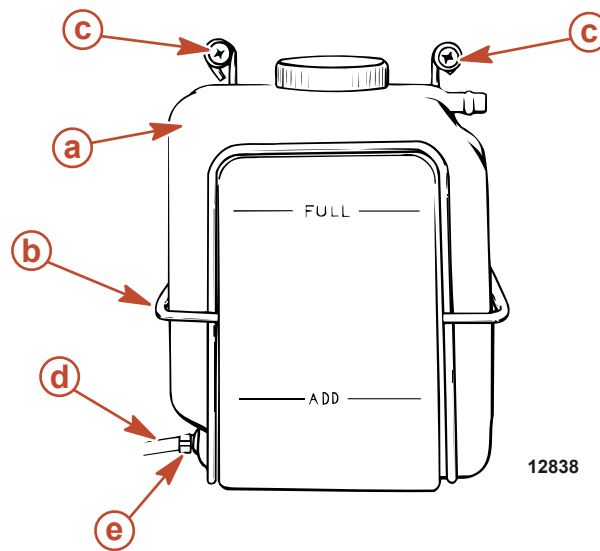
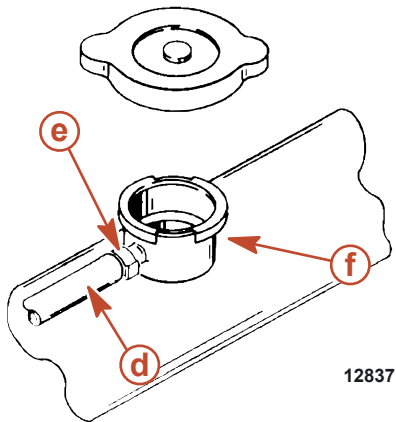
Coolant Recovery System

This system is equipped with a coolant recovery system that must be installed by the boat manufacturer. Coolant recovery bottle mounting location must meet these requirements:

- Within approximately 122 cm (4 ft.) of heat exchanger filler neck to allow connection with tubing provided.
- Even with or slightly above heat exchanger filler neck.

NOTE: *This differs from the previous recommendation and has been changed to ensure that air does not enter the cooling system upon cool down.*

- Accessible for observing level and servicing coolant.



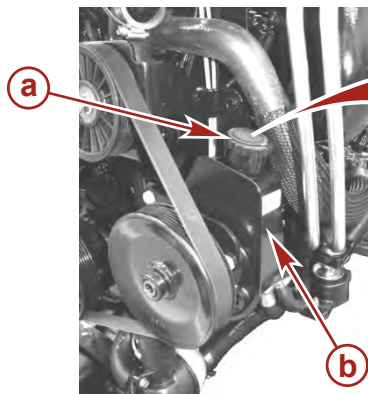
- a** - Recovery bottle
- b** - Mounting bracket
- c** - Screw and flat washer (2 each provided)
- d** - Plastic tubing
- e** - Tubing clamp
- f** - Heat exchanger fill neck

Power-Assisted Steering Fluid

Checking

Engine at Normal Operating Temperature

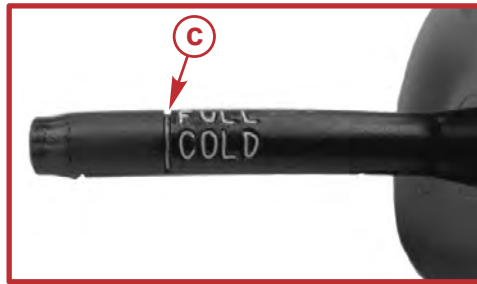
1. Stop the engine.
2. Center the sterndrive.
3. Remove the fill cap/dipstick from the power-assisted steering pump and note the fluid level.



48953

- a** - Fill cap/dipstick
- b** - Power-assisted steering pump

- The fluid level should be between the "HOT" mark and the "ADD" mark on the dipstick.



- a - "ADD" mark
- b - "HOT" mark
- c - "FULL COLD" mark

48955

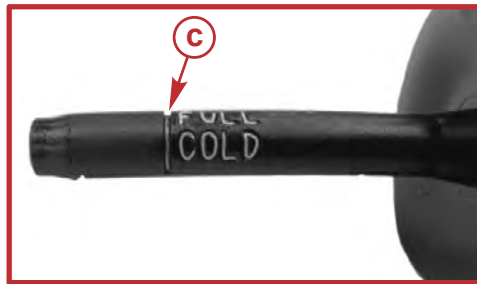
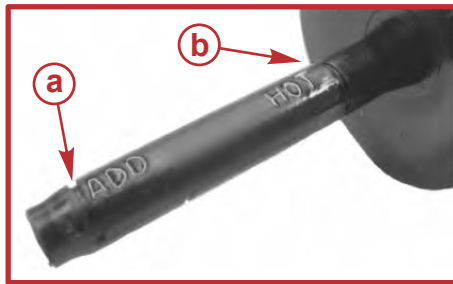
- If the fluid level is below the "ADD" mark, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the "HOT" mark on the dipstick. Do not overfill.

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

- If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct.

Engine Cold

- With the engine stopped, center the sterndrive.
- Remove the fill cap/dipstick from the power-assisted steering pump and note the fluid level.
- The fluid level should be between the "FULL COLD" mark and the bottom of the dipstick.



- a - "ADD" mark
- b - "HOT" mark
- c - "FULL COLD" mark

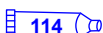
48955

- If the fluid level is below the bottom of the dipstick, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the "FULL COLD" mark on the dipstick. Do not overfill.
- If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct it.

Filling and Bleeding

IMPORTANT: The power-assisted steering system must be filled exactly as explained to ensure that all air is bled from the system. All air must be removed or fluid in the pump may foam during operation and be discharged from the pump reservoir. Foamy fluid may also cause the power-assisted steering system to become spongy, which may result in poor boat control.

- With the engine stopped, center the sterndrive.
 - Remove the fill cap/dipstick from the power-assisted steering pump.
- IMPORTANT:** Use only specified fluid in the power-assisted steering system.
- Add the specified fluid, as required, to bring the level up to the appropriate mark on the dipstick depending on the fluid temperature.

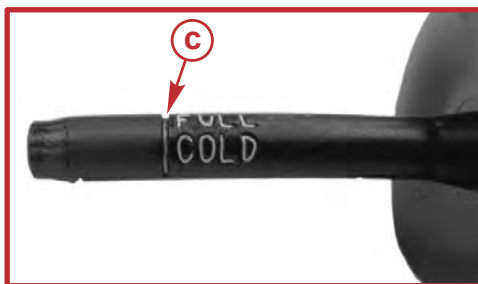
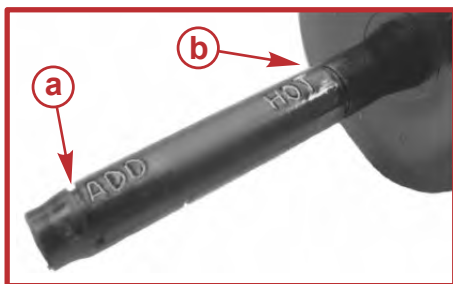
Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

- Turn the steering wheel back and forth to the end of travel in each direction several times.
- Recheck the fluid level and add fluid, if necessary.
- Install the fill cap/dipstick. Tighten securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. Supply cooling water to the engine.
8. Start the engine and operate at fast idle (1300 RPM) until the engine reaches normal operating temperature. During this time, turn the steering wheel back and forth to the end of travel in each direction several times.
9. Center the sterndrive and stop the engine.
10. Remove the fill cap/dipstick from the pump.
11. Allow any foam in the pump reservoir to disperse.
12. Check the fluid level and add fluid, as required, to bring the level up to the "HOT" mark on the dipstick. Do not overfill.



- a - "ADD" mark
- b - "HOT" mark
- c - "FULL COLD" mark

48955

13. Reinstall the fill cap/dipstick. Tighten securely.
IMPORTANT: The drive unit must be centered and the power-assisted steering fluid must be hot to accurately check the fluid level.
14. If the fluid is still foamy (in step 10), repeat steps 7–13 until the fluid does not foam and the level remains constant.

Changing

Power-assisted steering fluid does not require changing unless it becomes contaminated. Refer to **Section 8A - Power-Assisted Steering Pump and Related Components**.

Sterndrive Gear Lube

Checking

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: The oil level fluctuates during operation, so check with the engine cold before starting.

1. Check the gear lube oil level. Keep the oil level within the recommended operating range.
2. Inspect the gear lube oil in the monitor for any condition that may indicate a problem in the sterndrive. Some conditions that indicate a problem are:
 - a. Water is visible at the bottom of the gear lube monitor.
 - b. The gear lube appears milky.
 - c. The gear lube smells burned and looks dark.

- d. Metal particles are present in the gear lube.



43200

Gear lube monitor

Filling

New installations may require as much as 470 mL (16 fl oz) of gear lube added to the monitor bottle during the break-in period (20 hours of running time). It is important to monitor and maintain the gear lube level during the break-in period.

NOTE: If filling the entire sterndrive, refer to the appropriate sterndrive service manual.

1. Remove the gear lube monitor cap.
2. Fill the monitor with high performance gear lubricant until the fluid level is in the operating range. Do not overfill.

Tube Ref No.	Description	Where Used	Part No.
 87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01

3. Replace the cap.

Battery

Refer to specific instructions and warnings accompanying your battery. If this information is not available, observe the following precautions when handling a battery.

⚠ WARNING

Recharging a weak battery in the boat, or using jumper cables and a booster battery to start the engine, can cause serious injury or product damage from fire or explosion. Remove the battery from the boat and recharge in a ventilated area away from sparks or flames.

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

Multiple EFI Engine Battery Precautions

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for two different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI electronic control module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECMs minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself, and the engine will operate normally. The ECM shuts off and resets itself so quickly that the engine may only seem to have an ignition miss.

Batteries: Boats with multiengine EFI power packages require each engine be connected to its own battery. This ensures that the engine's ECM has a stable voltage source.

Battery switches: Battery switches should always be positioned so each engine is operating off of its own battery. Do not operate engines with switches in both or all position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

Generators: The generator's battery should be considered another engine's battery.

Water-Separating Fuel Filter (MPI)

Water-Separating Fuel Filter

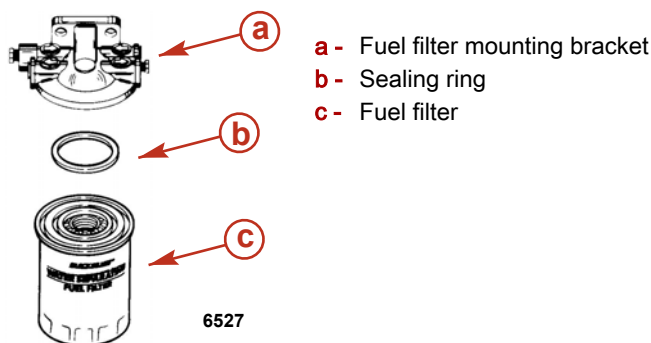
⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

Gen II Models



Removal

1. Allow the engine to cool down.
NOTE: Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.
2. Close the fuel supply valve, if equipped.
3. Wrap the water-separating fuel filter with a cloth to help catch any fuel spills or spray.
4. Remove and discard the water-separating fuel filter and sealing ring from the mounting bracket.

Installation

1. Coat the sealing ring on the new filter with engine oil.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Water-separating fuel filter sealing ring	Obtain Locally

2. Thread filter onto the mounting bracket and tighten securely by hand. Do not use a filter wrench.
3. Open fuel supply valve, if equipped.
4. Ensure that the engine compartment is properly ventilated.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

5. Supply cooling water to the engine.
6. Start the engine. Check for gasoline leaks around the fuel filter assembly. If leaks exist, stop the engine immediately. Recheck the filter installation, wipe up any spilled fuel, and properly ventilate the engine compartment. If leaks continue, stop the engine immediately and contact your authorized Mercury MerCruiser dealer.

Lubrication

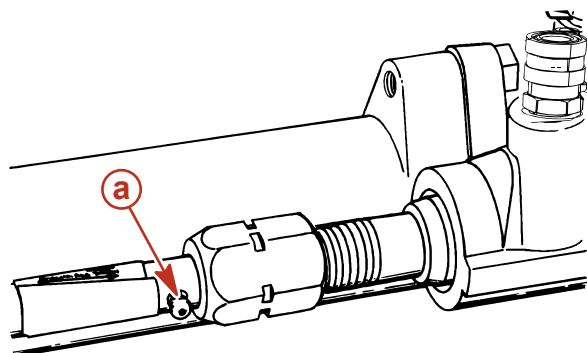
Steering System

⚠ WARNING

Incorrect cable lubrication can cause hydraulic lock, leading to serious injury or death from loss of boat control. Completely retract the end of the steering cable before applying lubricant.

NOTE: If the steering cable does not have a grease fitting, the inner wire of the cable cannot be greased.

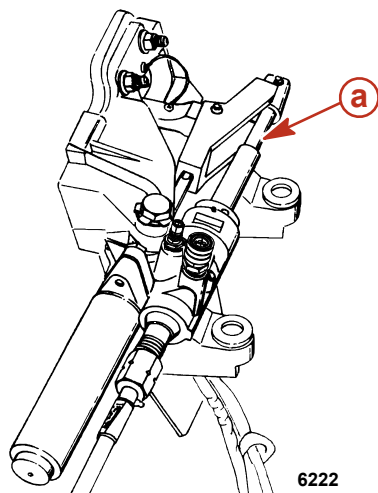
1. **If the steering cable has grease fittings:** Turn the steering wheel until the steering cable is fully retracted into the cable housing. Apply approximately three pumps of grease from a typical hand-operated grease gun.



a - Steering cable grease fitting

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Steering cable grease fitting	92-802859A 1

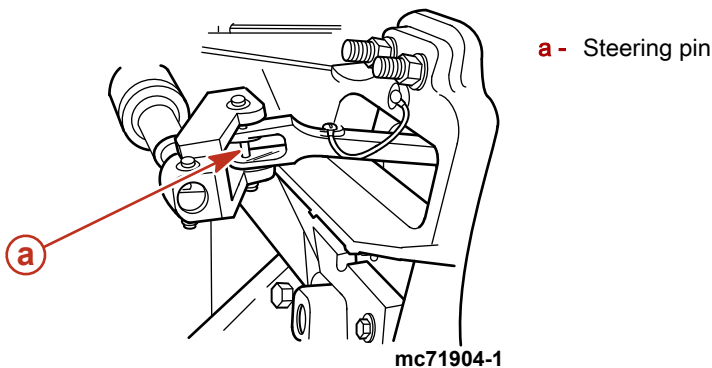
2. Turn the steering wheel until the steering cable is fully extended. Lightly lubricate the exposed part of the cable.



a - Extended steering cable

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Exposed part of steering cable	92-802859A 1

3. Lubricate the steering pin.



Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Steering pin	92-883725K01

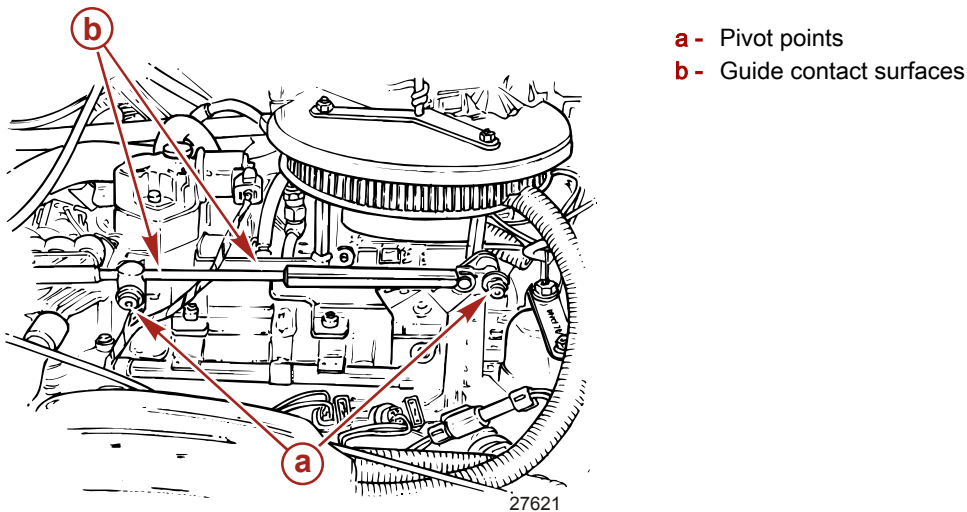
4. On dual engine boats: Lubricate the tie bar pivot points.

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Tie bar pivot points	92-883725K01

5. Upon first starting the engine, turn the steering wheel several times to starboard and then port to ensure that the steering system operates properly before getting underway.

Throttle Cable

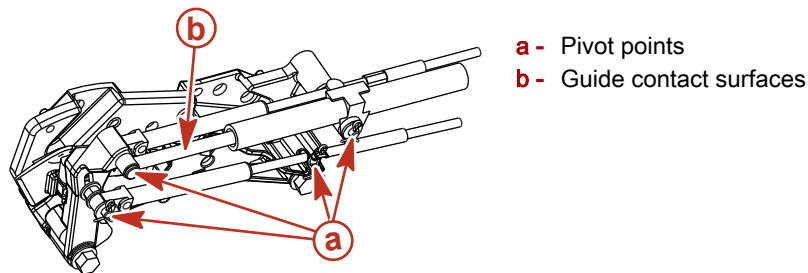
Lubricate the pivot points and the guide contact surfaces.



Tube Ref. No.	Description	Where Used	Part No.
 139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Pivot points and the guide contact surfaces	92-858052K01

Shift Cable - Typical

Lubricate the pivot points and the guide contact surfaces.

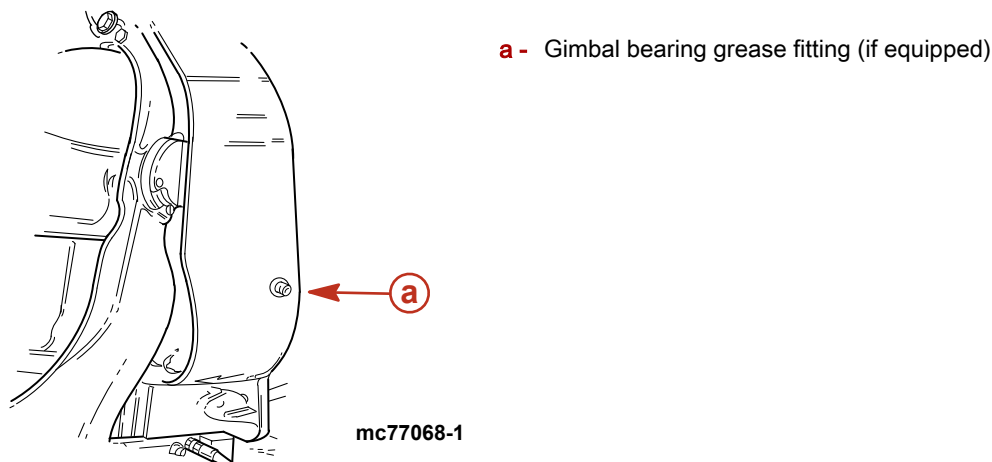


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Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Shift cable pivot points and guide contact surfaces	92-883725K01

Sterndrive Unit and Transom Assembly

1. Lubricate gimbal bearing by applying approximately 8–10 pumps of grease from a typical hand-operated grease gun.

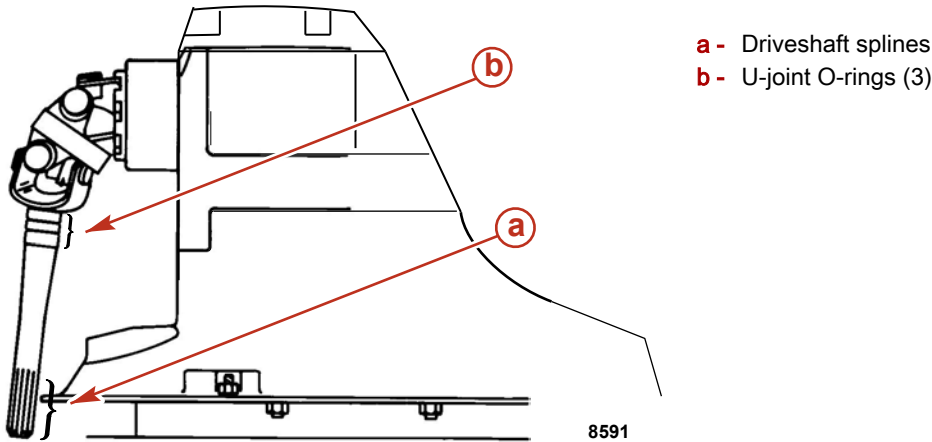


Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Gimbal bearing	8M0071842

2. For propeller shaft lubrication, refer to **Propellers**.

Sterndrive U-Joint Shaft Splines and O-Rings (Sterndrive Unit Removed)

1. Coat sterndrive U-joint O-rings and driveshaft splines with grease.



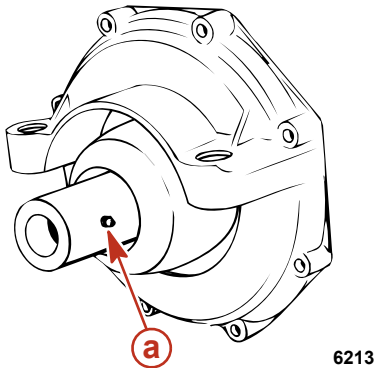
Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Driveshaft splines and U-joint O-rings	8M0071842

2. For propeller shaft lubrication, refer to **Propellers**.

Engine Coupler

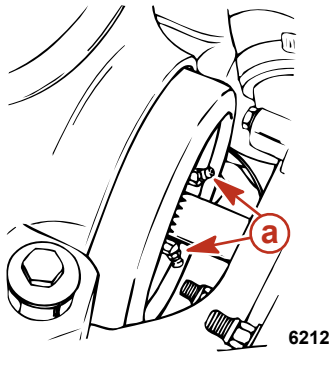
Lubricate the engine coupler splines through the grease fittings on the coupler by applying approximately 8–10 pumps of grease from a typical hand-operated grease gun.

NOTE: If the boat is operated at idle for prolonged periods of time, the coupler should be lubricated: **Bravo Models** - every 50 hours; **Alpha Models** - every 150 hours.



Alpha drive coupler

a - Grease fitting



Bravo drive coupler

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Coupler	8M0071842

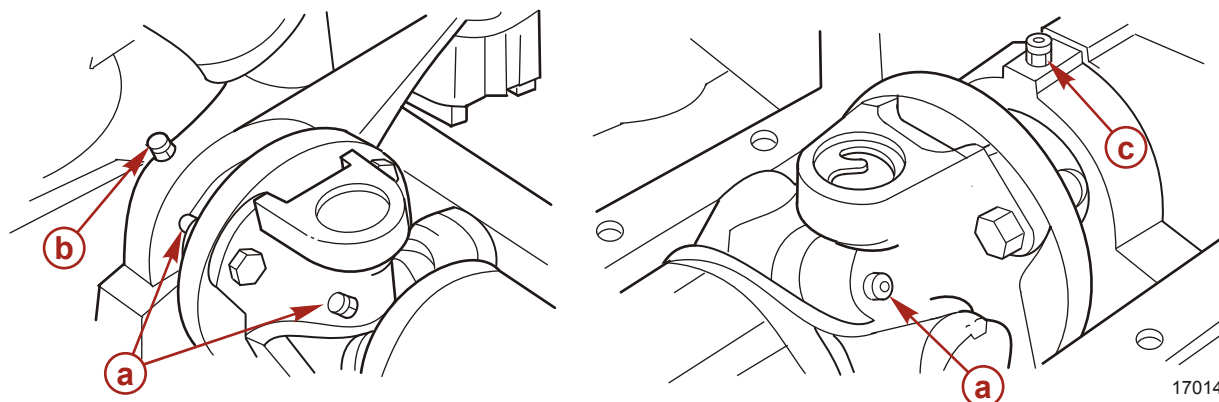
NOTE: Alpha Models - Your power package is equipped with a sealed engine coupler and Perm-a-Lube U-joints. The sealed coupler and shaft splines can be lubricated without removing the sterndrive unit. The Perm-a-Lube U-joints do not require lubrication.

NOTE: Bravo Models - The coupler and shaft splines can be lubricated without removing the sterndrive unit. Apply lubricant from a typical hand-operated grease gun until a small amount of grease begins to push out. The Perm-a-Lube U-joints do not require lubrication.

Driveshaft Extension Models

1. Lubricate the transom end grease fitting and engine end grease fitting by applying approximately 10–12 pumps of grease from a typical hand-operated grease gun.

- Lubricate the driveshaft grease fittings by applying approximately 3–4 pumps of grease from a typical hand-operated grease gun.



- a** - Driveshaft grease fittings
- b** - Transom end grease fitting
- c** - Engine end grease fitting

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Transom end grease fitting, engine end grease fitting, driveshaft grease fittings	8M0071842

Propellers

Propeller Repair

Some damaged propellers can be repaired. Contact your authorized Mercury MerCruiser dealer.

Alpha Propeller Removal

WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

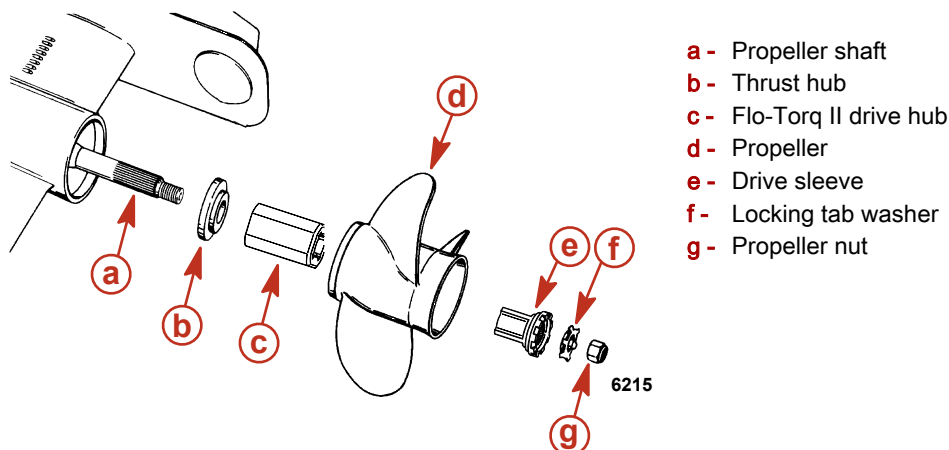
- Place a wood block between the propeller blade and the anti-ventilation plate to prevent rotation. Straighten bent tabs on tab washer.
- Turn the propeller shaft nut counterclockwise to remove the nut.
- Slide the tab washer, drive sleeve, propeller, and thrust hub off the propeller shaft.

Alpha Propeller Installation

NOTICE

Operating the engine with a loose propeller can damage the propeller, the drive, or drive components. Always tighten the propeller nut or nuts to specification and check for tightness periodically and at the required maintenance interval.

IMPORTANT: If reusing the tab washer, carefully inspect tabs for cracks or other damage. Replace the tab washer if condition is questionable.



1. Apply a liberal coat of one of the following lubricants to the propeller shaft.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
	Extreme Grease	Propeller shaft	8M0071842

2. Slide the thrust hub onto the propeller shaft, with the stepped side toward the propeller hub.
3. Install the Flo-Torq II drive hub into the propeller.
NOTE: The drive sleeve is tapered and will slide fully into the propeller as the nut is tightened and properly torqued.
4. Align the splines and place the propeller on the propeller shaft.
5. Install the drive sleeve and locking tab washer.
6. Install and tighten the propeller nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller nut (minimum)	75	–	55

7. Bend three tabs on the tab washer down into the grooves in the spline washer. After the first use, bend the three tabs straight and retorque the propeller nut. Bend tabs back down into the spline washer. Check the propeller every 20 hours of operation. Do not operate with a loose propeller.

Bravo One Propeller Removal

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

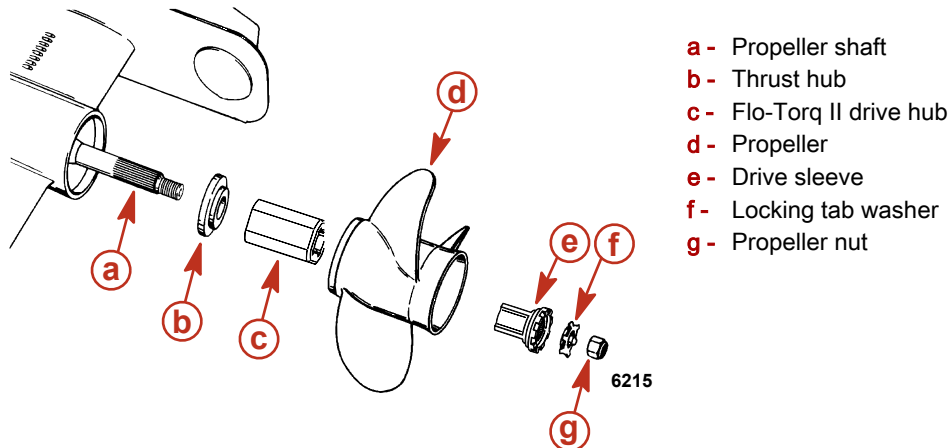
1. Place a wood block between the propeller blade and the anti-ventilation plate to prevent rotation. Straighten bent tabs on tab washer.
2. Turn the propeller shaft nut counterclockwise to remove the nut.
3. Slide the tab washer, drive sleeve, propeller, and thrust hub off the propeller shaft.

Bravo One Propeller Installation

NOTICE

Operating the engine with a loose propeller can damage the propeller, the drive, or drive components. Always tighten the propeller nut or nuts to specification and check for tightness periodically and at the required maintenance interval.

IMPORTANT: If reusing the tab washer, carefully inspect the tabs for cracks or other damage. Replace the tab washer if condition is questionable.



- Slide the thrust hub onto the propeller shaft, with the stepped side toward the propeller hub.
- Apply a liberal coat of one of the following lubricants to the propeller shaft.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
	Extreme Grease	Propeller shaft	8M0071842

- Install the Flo-Torq II drive hub into the propeller.
NOTE: The drive sleeve is tapered and will slide fully into the propeller as the nut is tightened and properly torqued.
- Align the splines and place the propeller on the propeller shaft.
- Install the drive sleeve and locking tab washer.
- Install and tighten the propeller nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller nut (minimum)	75	–	55

IMPORTANT: The propeller torque stated is a minimum torque value. Some special use propellers may have a different torque value. Use the installation information provided with the propeller to determine if another torque value is appropriate to your propeller.

- Bend three tabs on the tab washer down into the grooves in the spline washer. After the first use, bend the three tabs straight and retorque the propeller nut. Bend tabs back down into the spline washer. Check the propeller after 20 hours of operation. Do not operate with a loose propeller.

Bravo Two Propeller Removal

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

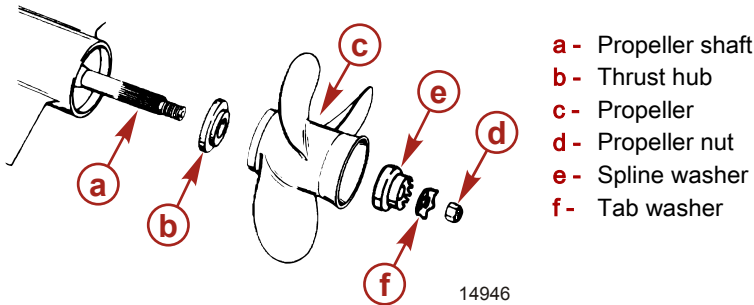
- Place a wood block between the propeller blade and anti-ventilation plate to prevent rotation. Straighten bent tabs on tab washer.
- Turn propeller shaft nut counterclockwise to remove nut.
- Slide tab washer, spline washer, propeller, and thrust hub off propeller shaft.

Bravo Two Propeller Installation

NOTICE

Operating the engine with a loose propeller can damage the propeller, the drive, or drive components. Always tighten the propeller nut or nuts to specification and check for tightness periodically and at the required maintenance interval.

IMPORTANT: If reusing the tab washer, carefully inspect tabs for cracks or other damage. Replace the tab washer if condition is questionable.



1. Slide the thrust hub onto the propeller shaft, with the stepped side toward the propeller hub.
2. Apply a liberal coat of one of the following lubricants to the propeller shaft.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
	Extreme Grease	Propeller shaft	8M0071842

3. Align the splines and place the propeller on the propeller shaft.
4. Install the spline washer and tab washer.
5. Install and tighten the propeller nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller nut (minimum)	81	–	60

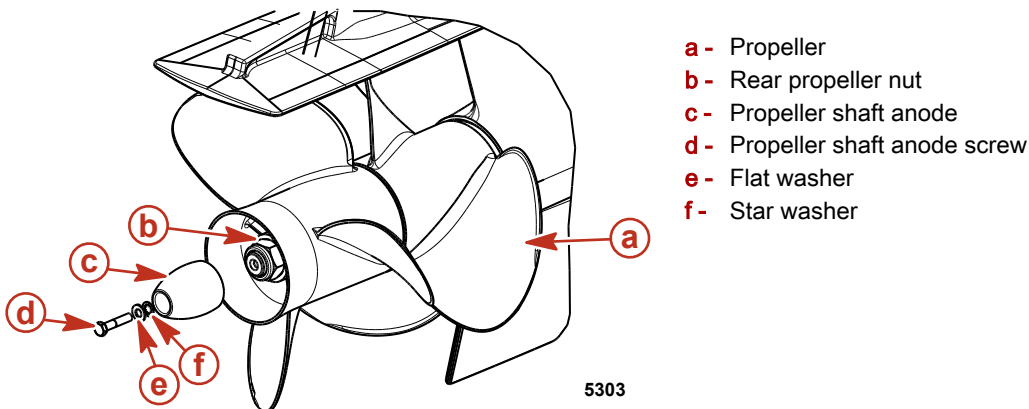
6. Bend three tabs on the tab washer down into the grooves in the spline washer. After the first use, bend the three tabs straight and retorque the propeller nut. Bend the tabs back down into the spline washer. Check the propeller every 20 hours of operation. Do not operate with a loose propeller.

Bravo Three Propeller Removal

⚠ WARNING

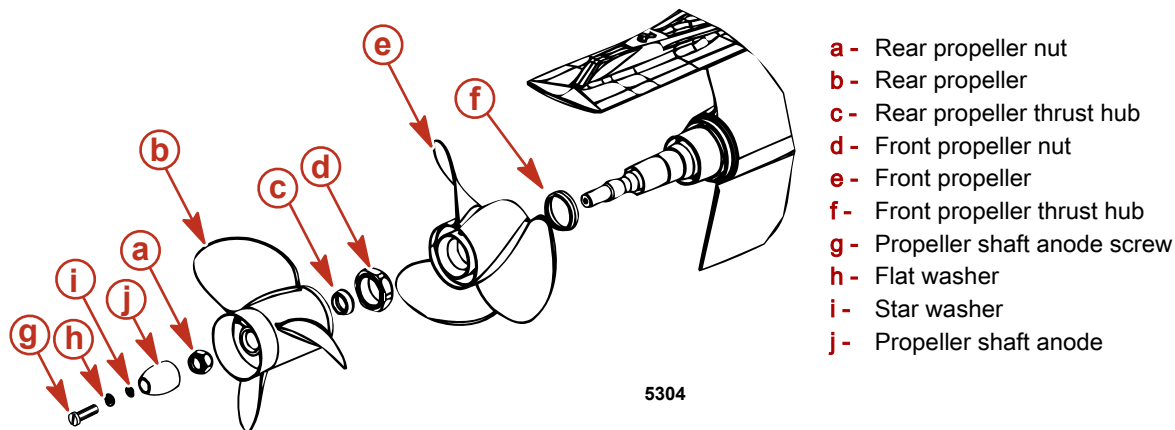
Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. Place a wood block between the propeller blades and the anti-ventilation plate to prevent rotation.
2. Remove the bolt and washers securing the propeller shaft anode.
3. Remove the propeller shaft anode.



4. Turn the rear propeller nut 37 mm (1-7/16 in.) counterclockwise to remove the nut.
5. Slide the propeller and thrust hub off the propeller shaft.
6. Turn the front propeller nut 70 mm (2-3/4 in.) counterclockwise to remove the nut.
7. Slide the propeller and thrust hub off the propeller shaft.

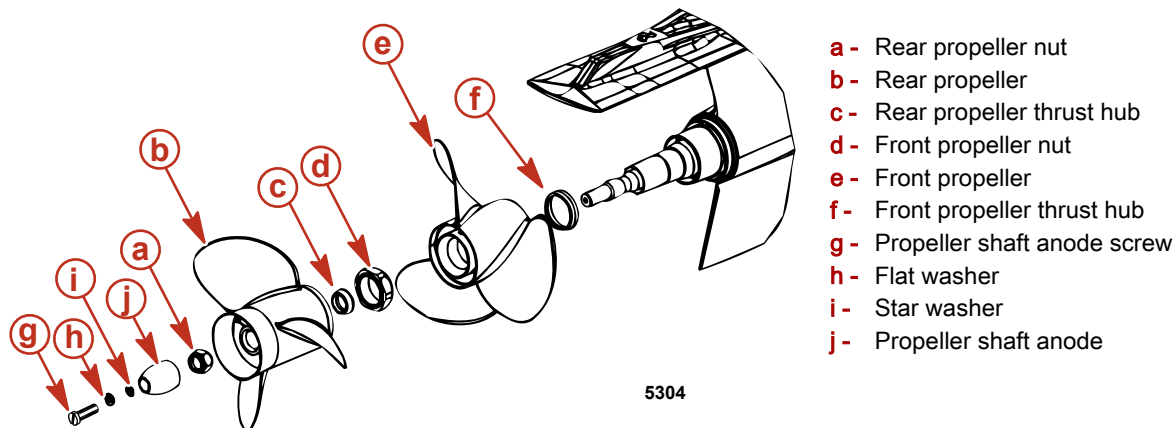
NOTE: Some damaged propellers can be repaired. Contact your authorized Mercury MerCruiser dealer.



Bravo Three Propeller Installation

NOTICE

Operating the engine with a loose propeller can damage the propeller, the drive, or drive components. Always tighten the propeller nut or nuts to specification and check for tightness periodically and at the required maintenance interval.



- Slide the front propeller thrust hub onto the propeller shaft with the outside taper facing toward the propeller hub (toward end of propeller shaft).
- Apply a liberal coat of one of the following lubricants to the propeller shaft.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
	Extreme Grease	Propeller shaft	8M0071842

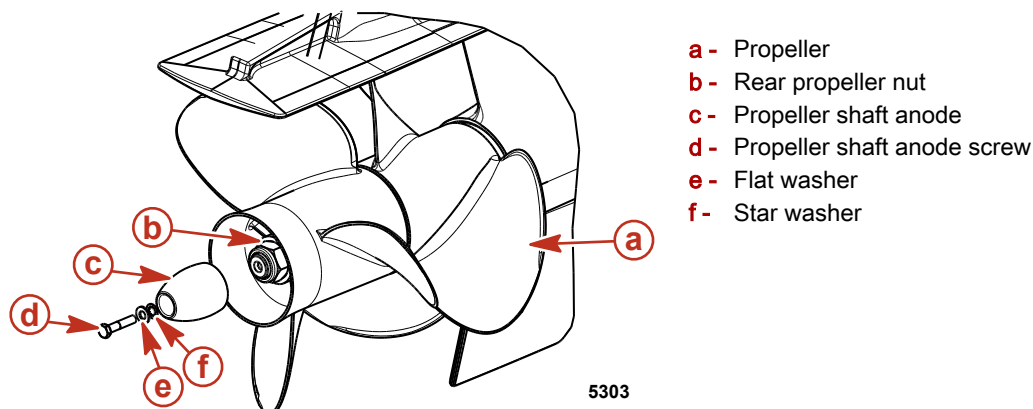
- Align the splines and install the front propeller onto the propeller shaft.
- Install and tighten the front propeller nut to the specified torque. Check the propeller every 20 hours of operation and retighten as needed.

Description	Nm	lb-in.	lb-ft
Front propeller nut	136	–	100

- Slide the rear thrust hub onto the propeller shaft with the outside taper facing toward the propeller hub (toward end of propeller shaft).
- Align the splines and install the rear propeller onto the propeller shaft.
- Install and tighten the rear propeller nut to the specified torque. Check the propeller every 20 hours of operation and retighten as needed.

Description	Nm	lb-in.	lb-ft
Rear propeller nut	81	–	60

8. Install the propeller shaft anode over the rear propeller nut.
9. Place the flat washer onto the propeller shaft anode screw.
10. Place the star washer onto the propeller shaft anode screw.
11. Apply Loctite 271 Threadlocker onto the propeller shaft anode screw threads.



Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Propeller shaft anode screw threads	92-809819

12. Secure the propeller shaft anode to the propeller shaft with the propeller shaft anode screw and washers. Tighten the anode screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller shaft anode screw 38 mm (0.3125-18 x 1.5 in.) long	27	–	20

Corrosion Protection

Corrosion Information

Whenever two or more dissimilar metals are submerged in a conductive solution, such as saltwater, polluted water or water with a high mineral content, a chemical reaction takes place causing electrical current to flow between metals. The electrical current flow causes the metal that is most chemically active, or anodic, to erode. This is known as galvanic corrosion.

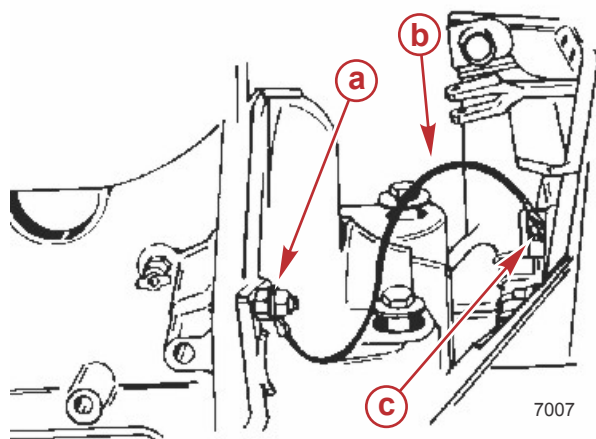
Maintaining Ground Circuit Continuity

The transom assembly and sterndrive are equipped with a ground wire circuit to ensure good electrical continuity between the engine, transom assembly, and sterndrive components. Good continuity is essential for the anode and the MerCathode system to function effectively.

Inspect all ground circuit components for loose connections and broken or fraying wires.

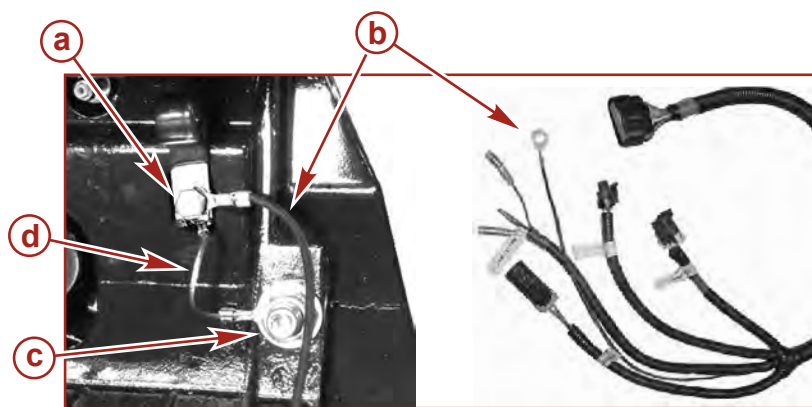
Maintenance

Models equipped with a separate ground wire must have the wire connected between the engine flywheel housing and the transom plate.

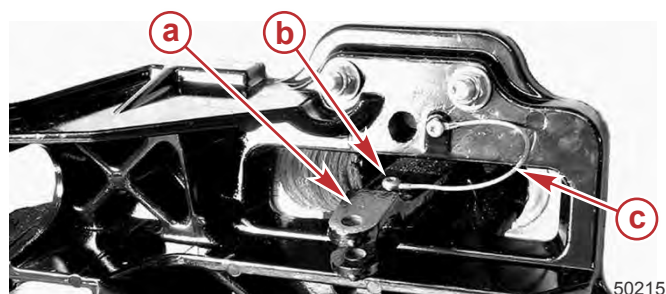


- a** - Engine flywheel housing bolt
- b** - Ground wire
- c** - Inner transom plate grounding screw

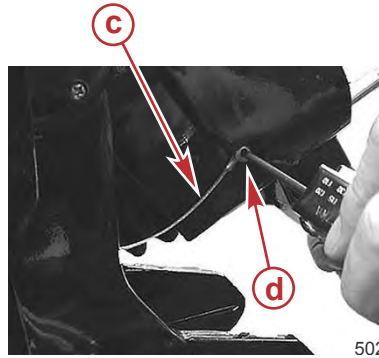
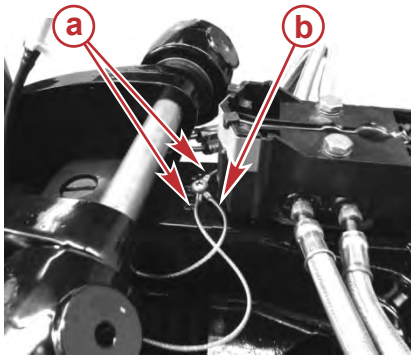
Models equipped with a transom harness must connect its ground wire to the grounding screw on the gimbal housing.



- a** - Gimbal housing grounding screw
- b** - Transom harness ground wire to engine harness
- c** - Transom plate grounding stud and nut
- d** - Grounding wire gimbal housing to transom plate



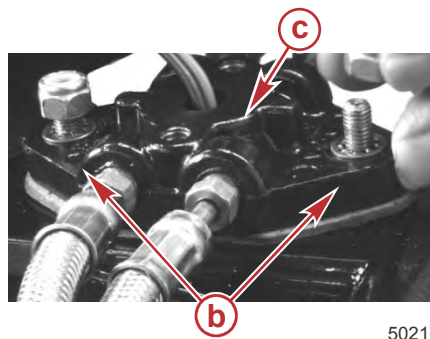
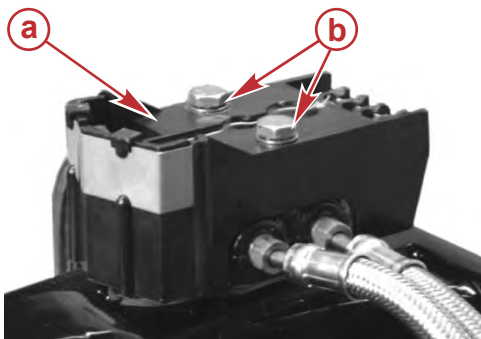
- a** - Steering lever
- b** - Torx® screw
- c** - Continuity wire



50216

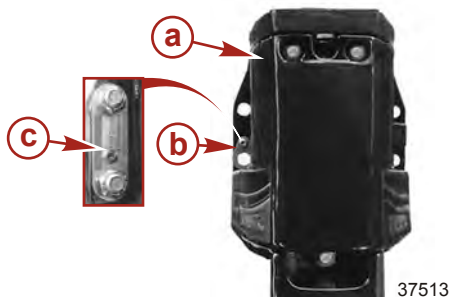
Bravo model shown, Alpha similar

- a** - Trim-cylinder-to-gimbal-ring ground wire (2)
- b** - Gimbal-housing-to-gimbal-ring ground wire
- c** - Gimbal-ring-to-bell-housing ground wire
- d** - Screw



50217

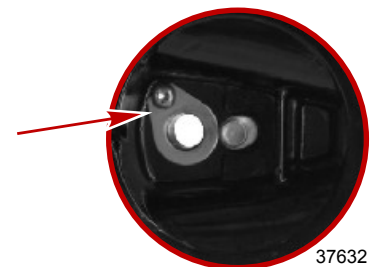
- a** - MerCathode
- b** - Continuity washers
- c** - Hydraulic manifold



37513

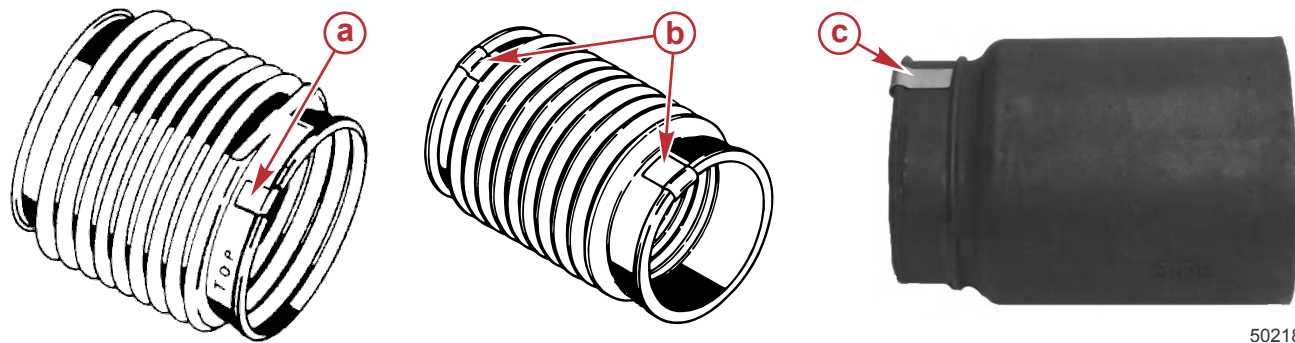
Bravo sterndrive shown, Alpha sterndrive similar

- a** - Stern drive
- b** - Ground washer
- c** - Ground plate (later model)



37632

Ground washer shown inside anode cavity of Bravo Three gear housing, other models similar



50218

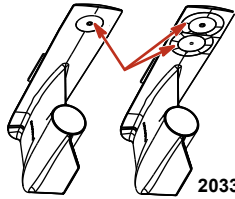
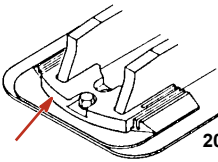
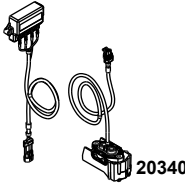
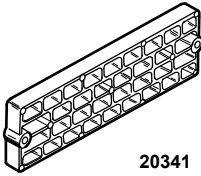
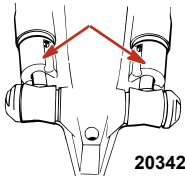
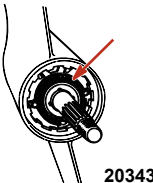
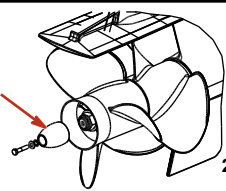
- a** - U-joint bellows ground clip
- b** - Exhaust bellows ground clip
- c** - Exhaust tube ground clip

Anodes and MerCathode System Locations

IMPORTANT: Replace sacrificial anodes if eroded 50 percent or more.

The following sacrificial anodes are installed at different locations on your power package. These anodes help protect against galvanic corrosion by sacrificing their metal to be slowly eroded instead of the metal components on the power package.

MerCathode system—Electrode assembly replaces the anode block. System should be tested to ensure adequate output. The test should be performed where boat is moored, using Quicksilver reference electrode and test meter.

Description	Location	Figure
Gearcase anode plate	Mounted on the underside of the lower gearcase.	 20336
Ventilation plate anode	Mounted on the front of the gearcase.	 20338
MerCathode system	The MerCathode electrode is mounted to the underside of the gimbal housing. The MerCathode controller is mounted on the engine or on the boat transom. The controller harness connects to the electrode harness.	 20340
Anode kit (if equipped)	Mounted to the boat transom.	 20341
Trim cylinder anodes	Mounted on each of the trim cylinders.	 20342
Bearing carrier anode (Bravo One)	Located in front of the propeller, between the front side of the propeller and the gear housing.	 20343
Propshaft anode (Bravo Three)	Located behind the aft propeller.	 20344

Checking the Quicksilver MerCathode System

The MerCathode system should be tested to ensure adequate output. Use a reference electrode and test meter to perform testing where the boat is moored. Refer to **MerCruiser Service Bulletin 2013-02**, or the **Marine Corrosion Protection Guide** for specific test parameters and detailed testing instructions.

Reference Electrode	91-76675T 1
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Power Package Exterior Surfaces

1. Spray the entire power package at recommended intervals with Corrosion Guard. Follow the instructions on the can for proper application.

Tube Ref No.	Description	Where Used	Part No.
 120	Corrosion Guard	Painted surfaces	92-802878 55

2. Clean the entire power package. External surfaces that have become bare should be repainted with the recommended primer and spray paint at recommended intervals.

Description		Part Number
Mercury Light Gray Primer	Painted surfaces	92-802878 52
Mercury Phantom Black		92-802878Q 1

Boat Bottom Care

To achieve maximum performance and fuel economy, the boat bottom must be kept clean. Accumulation of marine growth or other foreign matter can greatly reduce boat speed and increase fuel consumption. To ensure best performance and efficiency, periodically clean the boat bottom in accordance with manufacturer's recommendations.

In some areas, it may be advisable to paint the bottom to help prevent marine growth. Refer to the following information for special notes about the use of antifouling paints.

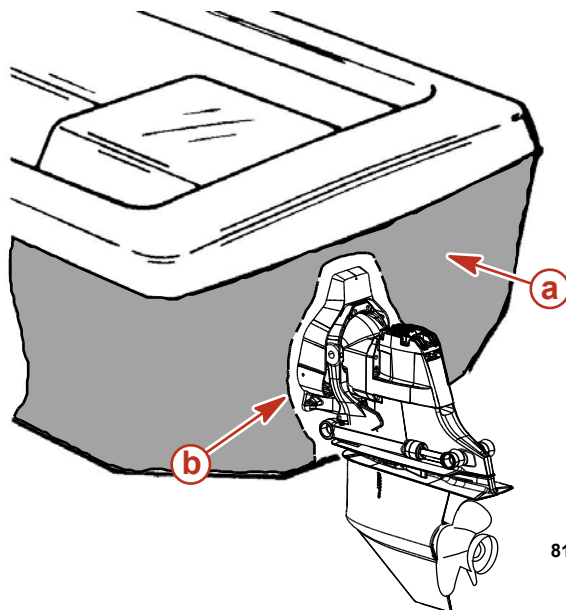
Antifouling Paint

IMPORTANT: Corrosion damage that results from the improper application of antifouling paint will not be covered by the product warranty.

IMPORTANT: Do not paint or pressure-wash the anodes or the MerCathode system reference electrode and anode. Doing so will render them ineffective as inhibitors of galvanic corrosion.

IMPORTANT: Use copper-based paint where not prohibited by law if antifouling protection is required for the boat hull or boat transom. Observe the following precautions:

- Avoid an electrical interconnection between the Mercury MerCruiser product, anodic blocks, or MerCathode system and the paint by allowing a minimum of 40 mm (1-1/2 in.) unpainted area on transom of the boat around these items.



- a - Painted boat transom
- b - Minimum 40 mm (1-1/2 in.) unpainted area around transom assembly

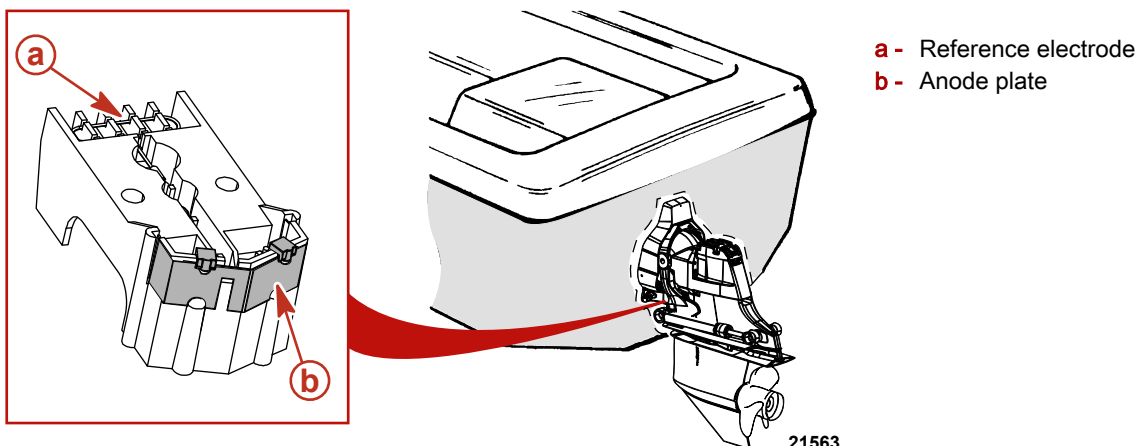
8107

NOTE: Sterndrive and transom assembly can be painted with a good marine paint or an antifouling paint that does not contain copper or any other material that could conduct electrical current. Do not paint drain holes, anodes, the MerCathode system, or items specified by the boat manufacturer.

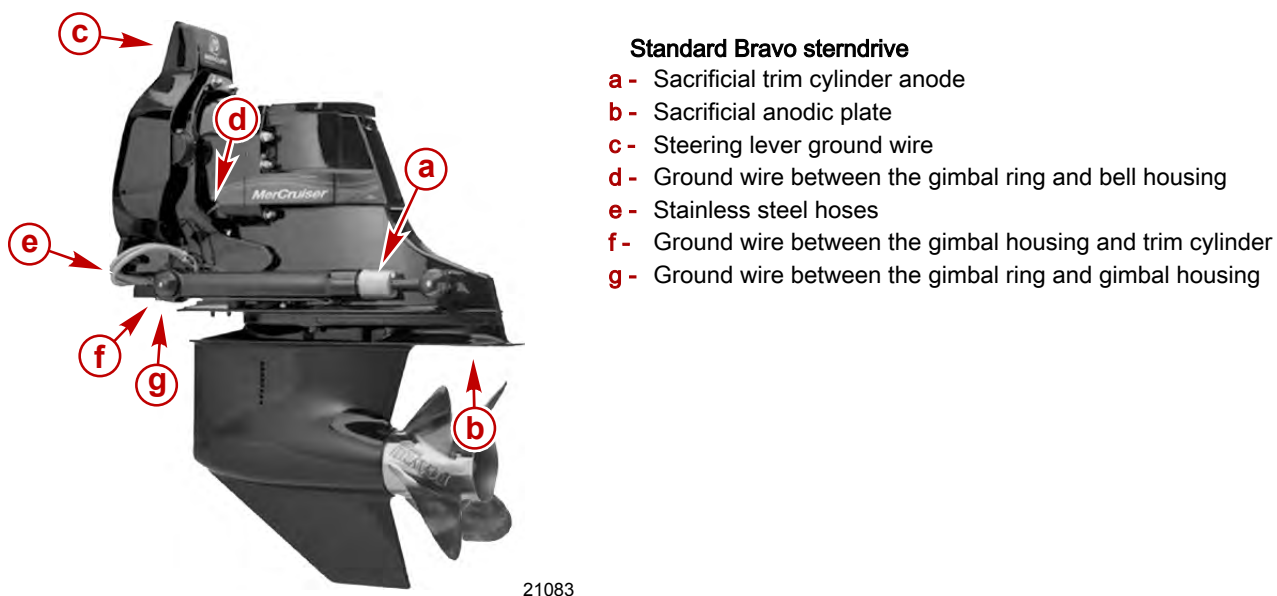
NOTICE

Washing the MerCathode assembly can damage components and lead to rapid corrosion. Do not use any cleaning equipment such as brushes or high-pressure washers to clean the MerCathode assembly.

Do not power-wash a sterndrive that has a MerCathode assembly. Doing so can damage the coating on the reference wire of the MerCathode assembly and increase corrosion.



Sterndrive Surface Care



We recommend the following maintenance items to help keep your sterndrive corrosion-free:

- Maintain a complete paint covering on the sterndrive.
- Check the finish regularly. Prime and paint nicks and scratches using Mercury enamel paint and touch up paint. Use only tin-based antifouling paint or its equivalent on or near aluminum surfaces below the waterline.
- If bare metal is showing, apply two coats of paint.

Description	Where used	Part number
Mercury Phantom Black	Bare metal	92- 802878-1

- Spray all electrical connections with sealant.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All electrical connections	92- 25711 3

- Inspect the sacrificial trim tab or anode plate if equipped, at regular intervals and replace it before it is half gone. If a stainless steel propeller is installed, additional anodes or a MerCathode system will be required.
- Inspect the propeller shaft for fishing line, which can cause corrosion on a stainless steel shaft.
- Remove the propeller at least every 60 days and lubricate the propeller shaft.
- Do not use lubricants containing graphite on or near the aluminum in saltwater.
- Do not paint trim tabs or the mounting surface.

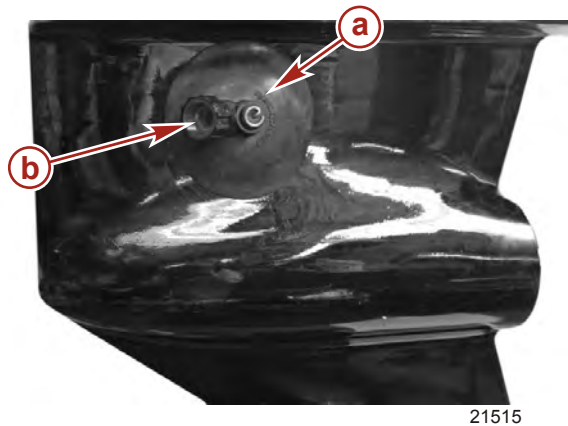
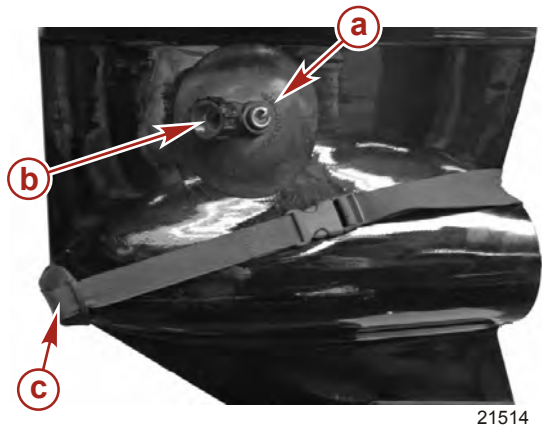
Flushing the Power Package

Your boat could come equipped with a combination of any of three different types of water pickups: through the hull, through the transom, and through the sterndrive. The flushing procedures for these systems are separated into two categories: sterndrive water pickups and alternative water pickups. Consult your authorized Mercury MerCruiser dealer for further explanation.

IMPORTANT: Bravo models equipped with closed cooling require dual water pickups and must be equipped with a through-hull or through-transom pickup in addition to the sterndrive water inlets.

IMPORTANT: Alpha engines with the sterndrive water inlet blocked off at the gimbal housing, and using a through-hull water inlet, need a supply of cooling water available to both the sterndrive and to the engine during operation

Flushing Attachments



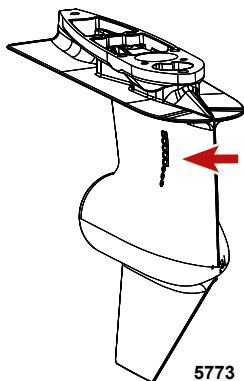
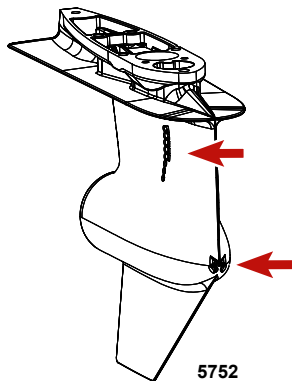
- Flushing attachments for dual water pickup**
- a - Flushing device
 - b - Hose attachment
 - c - Dual water pickup flush gearcase seal kit

Flushing attachments for side water pickup

Flushing Device	91-44357Q 2
Dual Water Pick-up Flush Gearcase Seal Kit	91-881150K 1

Sterndrive Water Pickups

There are two types of water pickups available on Mercury MerCruiser sterndrives: dual water, and side pickups. Dual water pickups require the flushing attachment (44357Q 2) and the flush seal kit (881150K 1), and side pickups require the flushing attachment (44357Q 2).



Dual Water Pickup

Side Pickup

NOTE: Flushing is needed only for salty, brackish, mineral laden or polluted water applications. Flushing is recommended after each outing for best results.

NOTICE

Flushing the engine with the boat in the water can cause seawater to flow into the engine, resulting in engine damage. Close the seacock before flushing the engine. Keep the seacock closed until starting the engine.

1. On seawater cooled models: Proceed to Step 4. or Step 5.
2. **On Alpha closed cooled models with the sterndrive seawater inlet blocked:** Flushing water will need to be supplied to the sterndrive and to the engine. See **Alternative Water Pickups**.
3. **On Bravo closed cooled models using the sterndrive seawater inlet and a through-hull or through-transom alternative water pickup:** Flushing water will need to be supplied to only the sterndrive by taking the following steps to block, or disconnect and block, the hose from the alternative seawater pickup pump inlet Y-fitting.
 - a. If equipped with a seacock, close the seacock in the hose from the alternative water pickup.
 - b. If not equipped with a seacock, disconnect the hose from the alternative water pickup and plug both ends.
 - c. If there is not a hose running to the transom, refer to **Alternative Water Pickups**.
4. If flushing the cooling system with the boat in the water:
 - a. Raise sterndrive to trailer position.
 - b. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
 - c. Lower sterndrive to full down (in) position.
5. If flushing the cooling system with the boat out of the water:
 - a. Lower sterndrive to full down (in) position.

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

- b. Remove propeller.
 - c. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
6. Connect hose between flushing attachment and water source.
7. With sterndrive in normal operating position, open the water source fully.
8. Place the remote control in the neutral idle speed position and start engine.

NOTICE

Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

9. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate engine with sterndrive in neutral for about 10 minutes or until discharge water is clear.
12. Slowly return throttle to idle speed position.
13. Stop engine.
14. Shut off water and remove flushing attachment.
15. Remove the seawater inlet hose from the seawater pump and plug the hose to prevent water from siphoning into the engine.
16. Tag the ignition switch with an appropriate tag requiring the seawater inlet hose to be reconnected prior to operating engine.

Alternative Water Pickups

IMPORTANT: Two water sources are needed for this procedure.

NOTE: Flushing is needed only for salty, brackish, mineral laden or polluted water applications. Flushing is recommended after each outing for best results.

IMPORTANT: Engines with the sterndrive water inlet blocked off at the gimbal housing and using a through-hull water inlet need a supply of cooling water available to both the sterndrive and to the engine during operation.

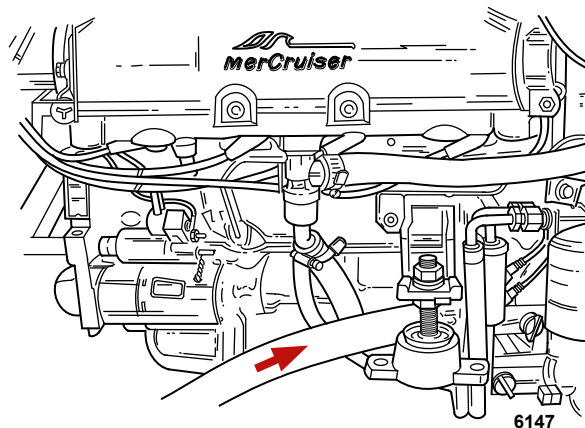
1. If flushing the cooling system with the boat in the water:

- a. Raise sterndrive to trailer position.
 - b. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
 - c. Lower sterndrive unit to full down (in) position.
2. If flushing the cooling system with the boat out of the water:
- a. Lower sterndrive to full down (in) position.

WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

- b. Remove propeller.
 - c. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
3. Connect hose between flushing attachment and water source.
4. Close the seacock, if equipped, to prevent water from siphoning into the engine or boat.
5. Remove the seawater inlet hose from the seawater pump and plug the hose to prevent water from siphoning into the engine or boat.



6. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. With sterndrive in normal operating position, open the water source fully.
8. Place the remote control in neutral idle speed position and start engine.

NOTICE

Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

9. Slowly advance throttle until engine reaches 1300 RPM (+/-100 RPM).
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate engine with sterndrive in neutral for about 10 minutes or until discharge water is clear.
12. Slowly return throttle to idle speed position.
13. Stop engine.
14. Shut off the water and remove flushing attachments.
15. **If the boat is out of the water:** Install the water inlet hose to the aft side of the seawater pump. Tighten the hose clamp securely.
16. **If the boat is in the water:** Tag the ignition switch with an appropriate tag requiring the seawater inlet hose to be reconnected prior to operating engine.

SeaCore Power Package Flushing Procedure

NOTE: Flushing is needed only for salty, brackish, mineral-laden, or polluted water applications. Flushing is recommended after each outing for best results.

IMPORTANT: Flushing the SeaCore power package with the boat and sterndrive in the water is less effective. Flushing the SeaCore power package is most effective when performed with the boat and sterndrive out of the water, such as on a boat lift or trailer.

Models Using The Sterndrive Water Pickup

IMPORTANT: The system is designed to flush the Bravo sterndrive and the engine with one water source. Do not block or remove the inlet water hose from the sterndrive to the engine.

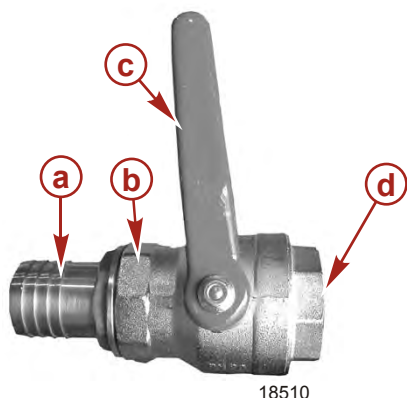
NOTE: Engines with the sterndrive water inlet blocked off at the gimbal housing: Refer to **Alternative Water Pickups**.

WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

IMPORTANT: Do not allow the engine to pull air or seawater from alternative water pickup sources during the flushing procedure. If equipped, ensure that all alternative water inlet hoses are plugged at both ends.

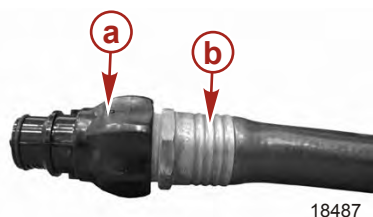
1. Remove the boat from the water.
2. Close the seacock, if equipped.



For visual clarity, the seacock shown is not installed

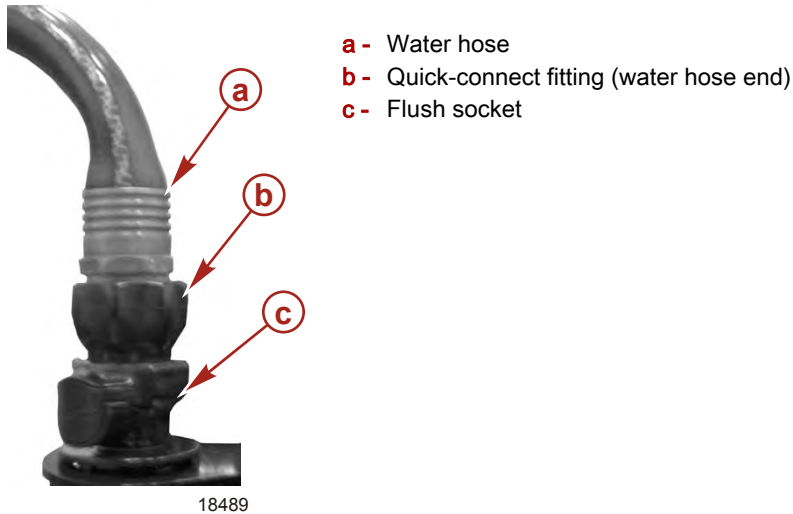
- a - Hose fitting to engine
- b - Seacock
- c - Handle (closed position)
- d - To water source pickup attachment

3. If equipped with an alternative water pickup and not equipped with a seacock, disconnect the water hose from the alternative water pickup and plug both ends, excluding the Bravo sterndrive.
4. Ensure that the inlet water hose from the sterndrive to the engine is connected.
5. Remove the quick-connect fitting from the parts bag supplied with the engine.
6. Attach the quick-connect fitting to a water hose.



- a - Quick-connect fitting (water hose end)
- b - Water hose

7. Snap the quick-connect fitting with the water hose into the flush socket on the engine.

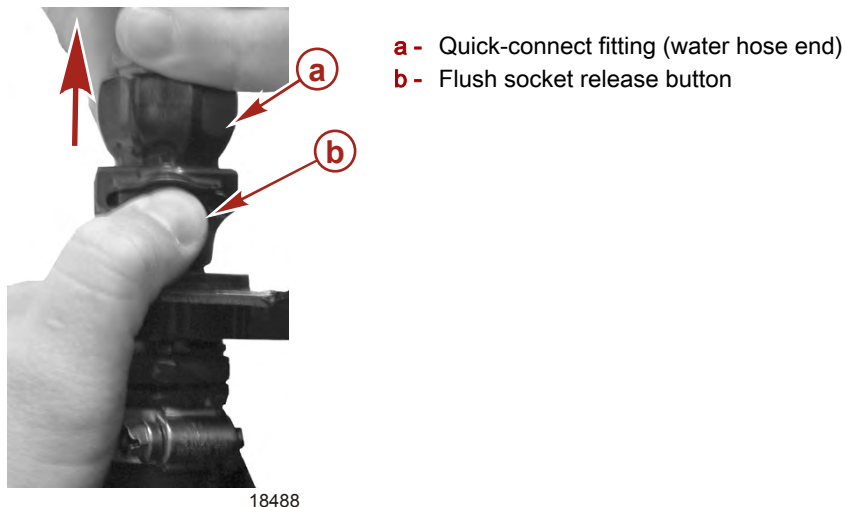


8. Open the water source of the water hose to a full flow.
9. Allow the water to flush the sterndrive for 30 seconds.
10. Place the remote control in neutral idle speed position and start engine.

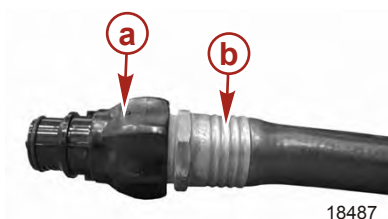
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

11. Operate the engine at idle speed in neutral gear. Do not exceed 1200 RPM.
12. Monitor the engine temperature while operating the engine.
13. Flush the engine for 5–10 minutes or until discharge water is clear.
14. Shut off the engine.
15. Allow the water to flush the sterndrive for 10 seconds.
16. Turn off the water source.
17. Disconnect the quick-connect fitting and water hose from the flush socket on the engine by pressing the release button on the flush socket.



18. Remove the quick-connect fitting from the water hose.



- a -** Quick-connect fitting (water hose end)
b - Water hose

19. Retain the quick-connect fitting with the water hose end for repeated use by storing it separately in a storage compartment on the boat for easy access.

IMPORTANT: Do not store the quick-connect fitting in the flush socket on the engine. Doing so would allow the seawater pump to suck air during engine operation causing an overheating problem. Damages due to engine overheating are not covered by Mercury MerCruiser Warranty.



- Quick-connect fitting stored in the boat**
a - Quick-connect fitting (water hose end)

20. Insert the dust cover in the flush socket on the engine.



- Dust cover installed in the flush socket**
a - Dust cover
b - Flush socket

IMPORTANT: If the unit is to be stored in the water, the seacock should remain closed until time of usage. If unit is to be stored out of the water, open the seacock.

21. Open the seacock, if equipped, or reconnect the alternative water inlet source prior to operating the engine.

Seawater System

Cleaning the Seawater Strainer, If Equipped

NOTICE

An open seawater strainer or seacock during some service or maintenance procedures can introduce water into the boat, causing damage or sinking the boat. Always close the water supply from the seawater pump, water inlet, or seacock when performing service or maintenance on the cooling system.

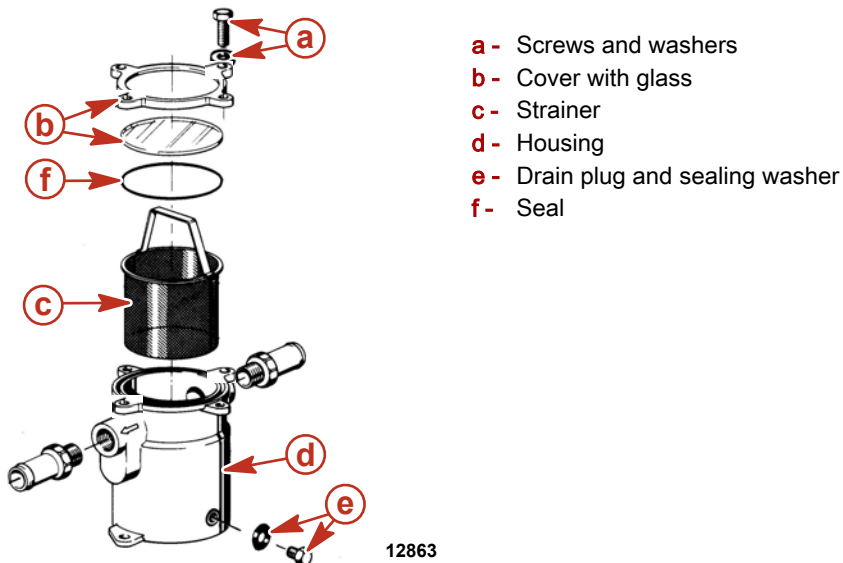
1. With the engine off, close the seacock, if equipped, or remove and plug the seawater inlet hose.
2. Remove the screws, washers, and cover.
3. Remove the strainer, drain plug, and sealing washer.
4. Clean all the debris from the strainer housing. Flush both the strainer and housing with clean water.

5. Check the cover gasket and replace when damaged or if it leaks.
6. Reinstall the strainer, drain plug, and sealing washer.

⚠ CAUTION

Seawater leaking from the seawater strainer could cause excess water in the bilge, damaging the engine or causing the boat to sink. Do not overtighten the cover screws, or the cover may warp and introduce seawater into the bilge.

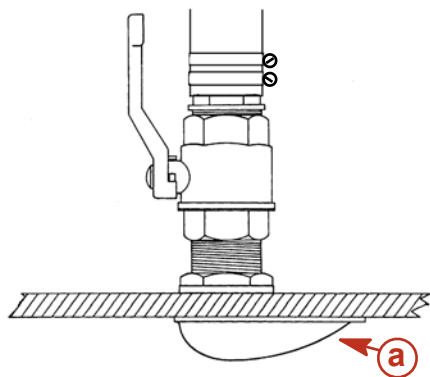
7. Install the seal and cover using the screws and washers. Do not overtighten the cover screws.



8. Open the seacock, if equipped, or remove the plug and reconnect the seawater inlet hose.
9. Upon first starting the engine, check for leaks or air in the system that would indicate an external leak.

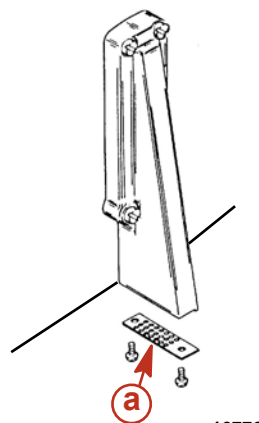
Checking the Seawater Pickups

Ensure that the water inlet holes for the seawater pickup are clean and unobstructed.



Typical through-the-hull seawater pickup

a - Water inlet holes



16776

Typical through-the-transom seawater pickup

Draining the Seawater System

⚠ CAUTION

Water can enter the bilge when the drain system is open, damaging the engine or causing the boat to sink. Remove the boat from the water or close the seacock, disconnect and plug the seawater inlet hose, and ensure the bilge pump is operational before draining. Do not operate the engine with the drain system open.

IMPORTANT: Only drain the seawater section of the closed cooling system.

IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

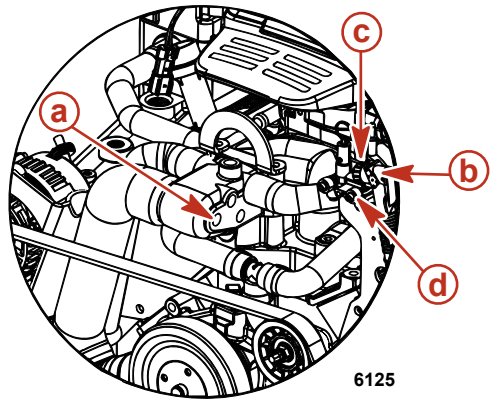
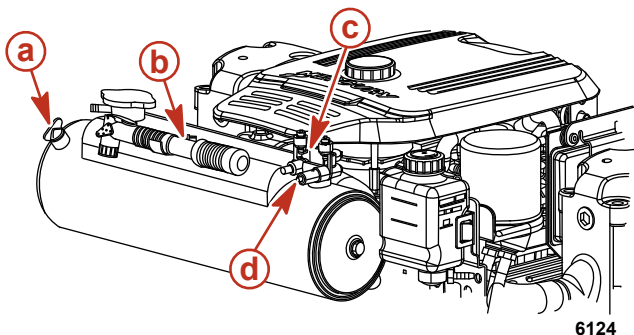
Your power package is equipped with a drain system. Refer to **Drain System Identification** to determine which instructions apply to your power package.

IMPORTANT: The engine must not be operating at any point during the draining procedure.

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Drain System Identification

Air Actuated Single-Point Drain System

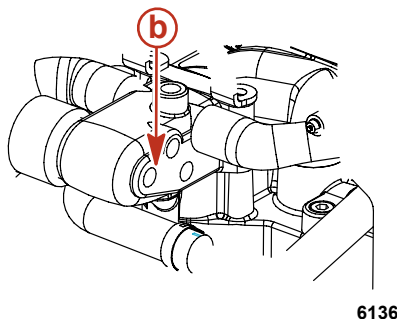
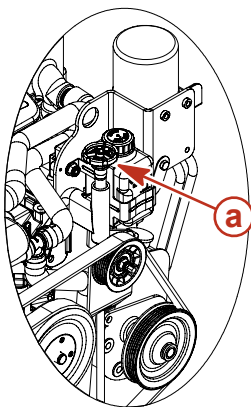


Closed cooling models

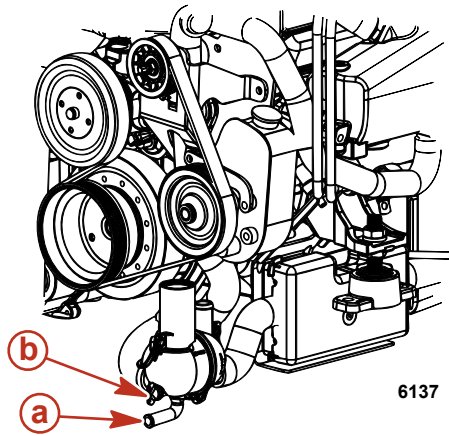
- a - Blue drain plug location
- b - Blue air pump
- c - Air manifold
- d - Green indicators

Seawater cooled models

Manual Single-Point Drain System

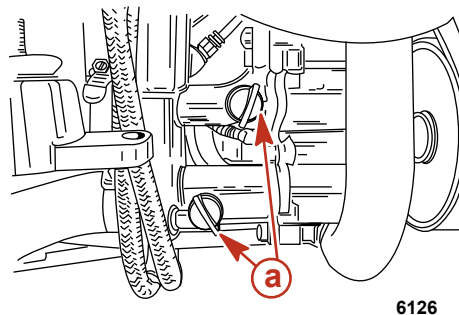
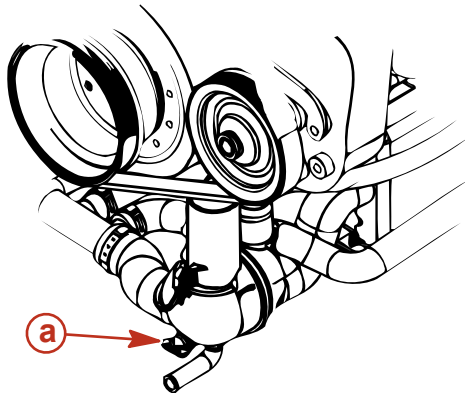


- a - Blue handle
- b - Blue drain plug location (vent)



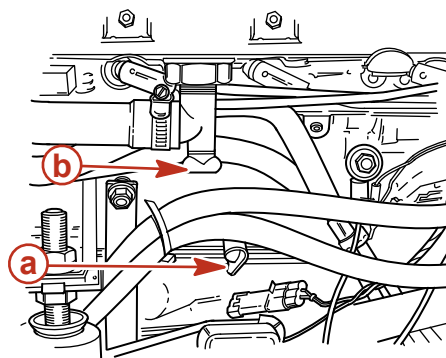
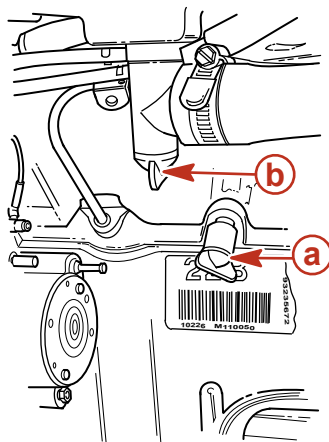
- a** - Drain location - orange or red
- b** - Blue drain plug

Three-Point Manual Drain System

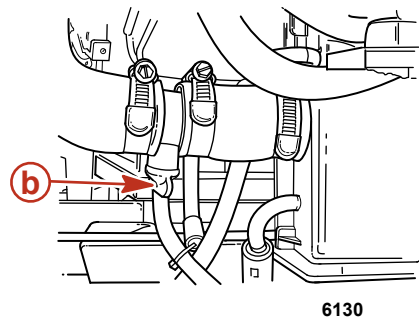
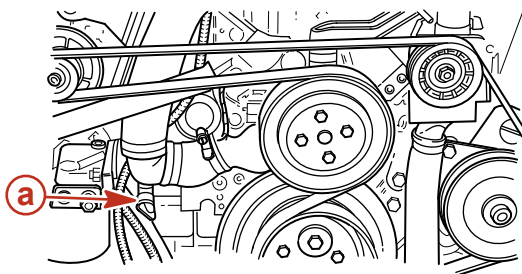


- a** - Blue drain plug (3)

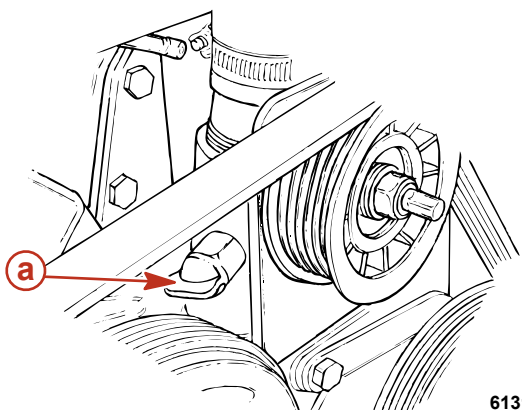
Multipoint Drain (MPD) System



- a** - Side of cylinder block (2)
- b** - Bottom of exhaust manifolds (2)



- a - Water circulating pump hose
- b - Fuel cooler to thermostat housing



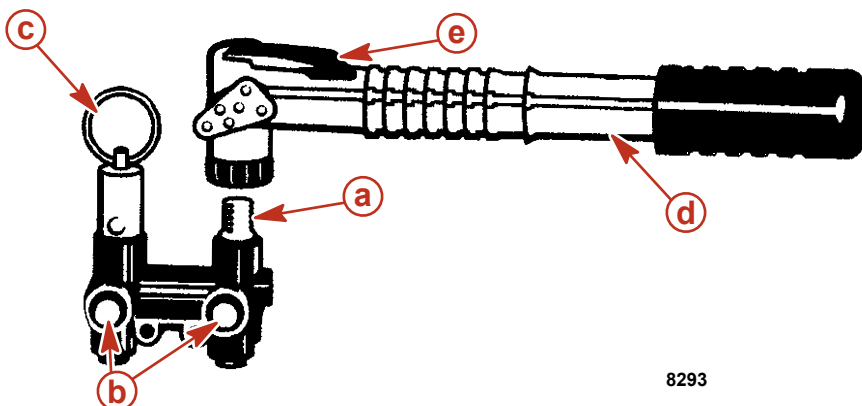
- a - Check valve (if equipped)

Air Actuated Single-Point Drain System

Boat in the Water

NOTE: This procedure is written for the air pump that is attached to the engine. However, any air source can be used.

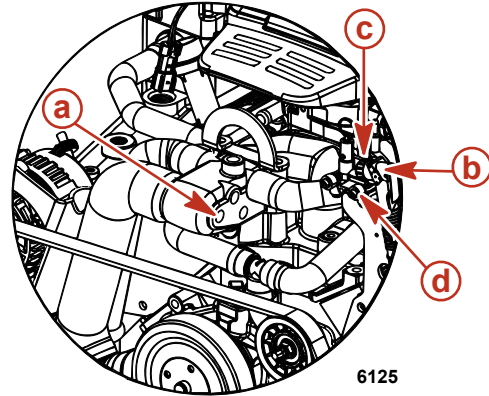
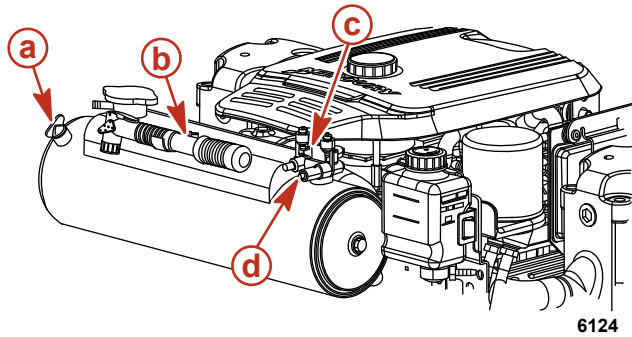
1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the air pump from the engine.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the actuator fitting.
5. Pull the lever on the air pump (vertical) to lock the pump on the fitting.



- a - Actuator fitting
- b - Green indicators
- c - Manual release valve
- d - Air pump
- e - Lever (locking)

6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.

7. Immediately remove the blue drain plug from the side of the thermostat housing or the heat exchanger. This must be removed within 30 seconds to properly vent the cooling system.

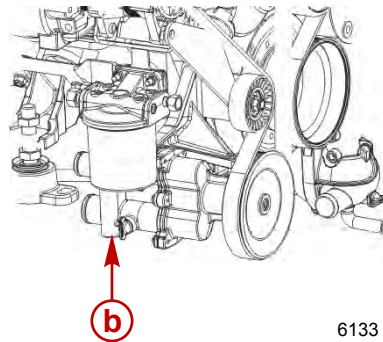
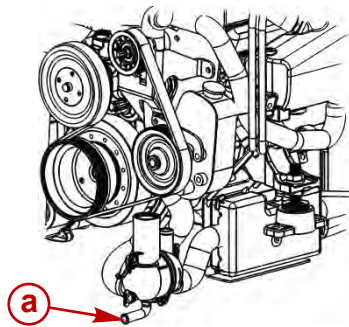


Closed cooling models

- a - Blue drain plug location (vent)
- b - Blue air pump
- c - Air manifold
- d - Green indicators

Seawater cooled models

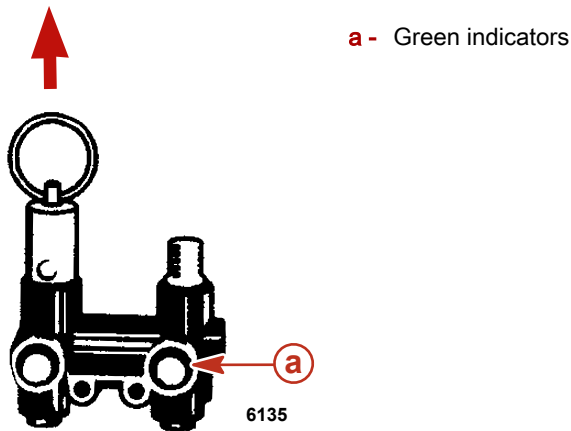
8. Verify that water is draining from each opening. If not, use the **Three-Point Manual Drain System** instructions.



- a - Port side drain location
- b - Starboard side drain location

9. Allow the system to drain for a minimum of five minutes. Pump air as necessary to keep the green indicators extended.
10. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
11. Reinstall the blue drain plug in the thermostat housing or heat exchanger.
12. Remove the air pump from the air manifold and return it to the mounting bracket.
13. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.

14. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.

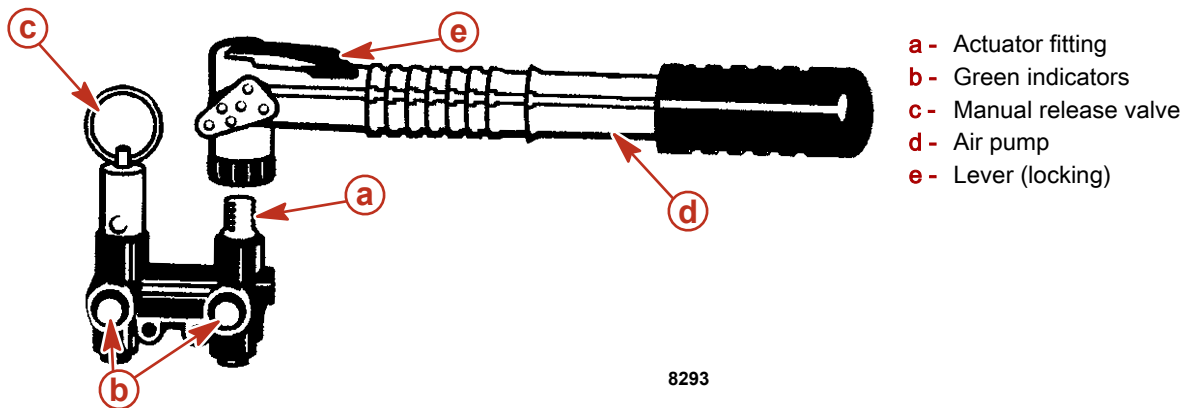


15. Open the seacock, if equipped, or unplug and reconnect the water inlet hose prior to operating the engine.

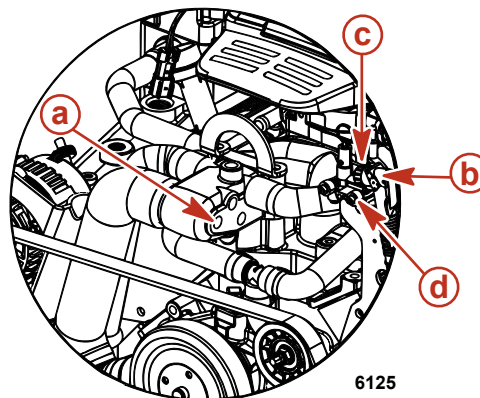
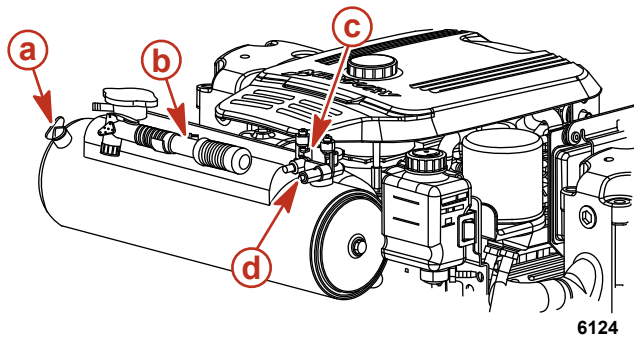
Boat Out of the Water

NOTE: This procedure is written for the air pump that is attached to the engine. However, any air source can be used.

1. Place the boat on a level surface to ensure complete draining of the system.
2. Remove the air pump from the engine.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the actuator fitting.
5. Pull the lever on the air pump (vertical) to lock the pump on the fitting.



6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.

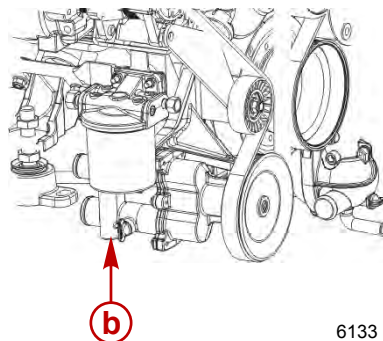
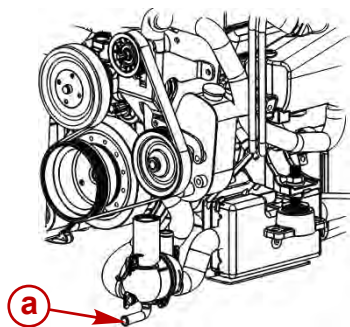


Closed cooling models

- a - Blue drain plug location
- b - Blue air pump
- c - Air manifold
- d - Green indicators

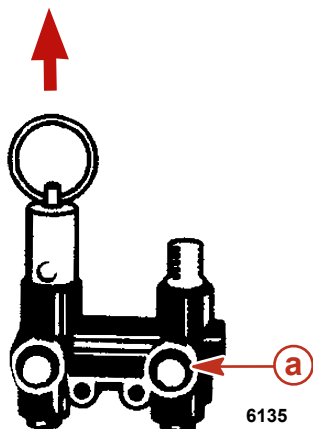
Seawater cooled models

7. Verify that water is draining from each opening. If not, use the **Three-Point Manual Drain System** instructions.



- a - Port side drain location
- b - Starboard side drain location

8. Allow the system to drain for a minimum of five minutes. Pump air as necessary to keep the green indicators extended.
9. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
10. Remove the air pump from the air manifold and return it to the mounting bracket.
11. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
12. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.

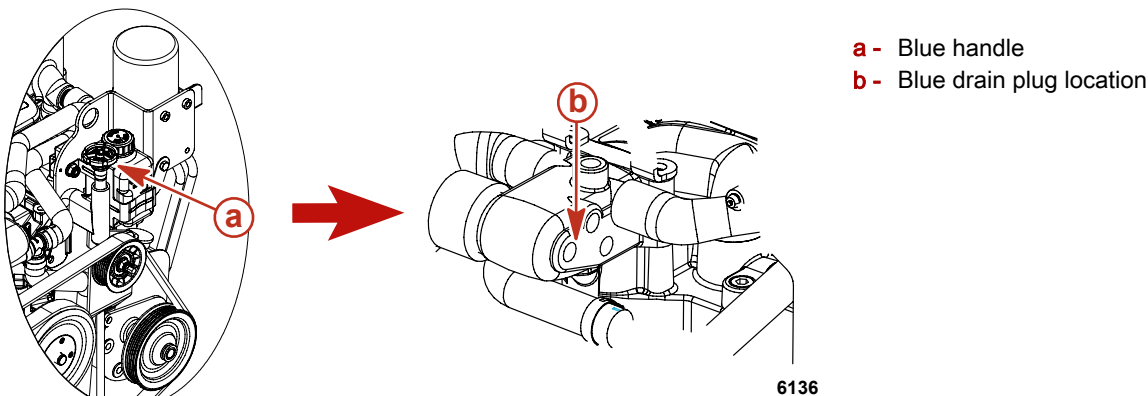


- a - Green indicators

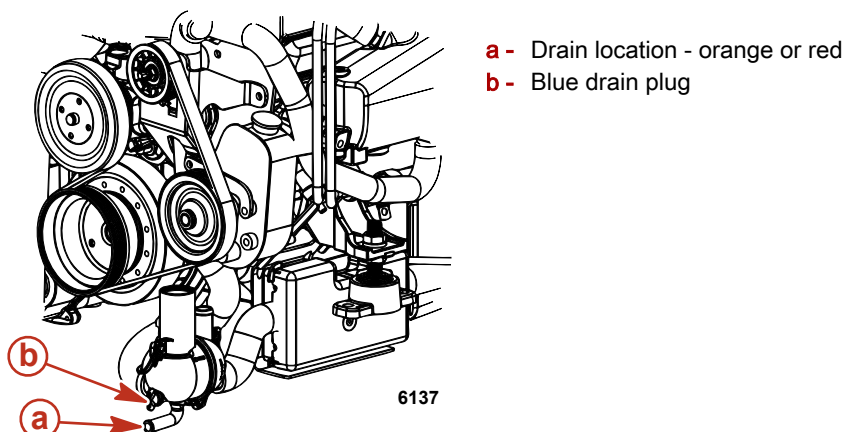
Manual Single-Point Drain System

Boat in the Water

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Rotate the blue handle counterclockwise until it stops (approximately two turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.
3. Immediately remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.



4. Visually verify that water is draining. If water does not drain, remove the blue drain plug from the distribution housing and drain manually.

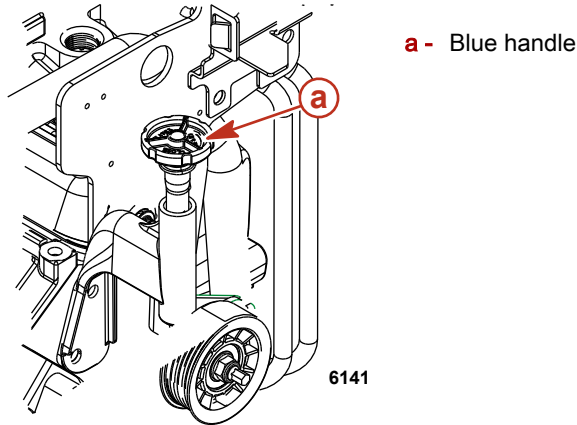


5. Allow the system to drain for a minimum of five minutes. We recommend leaving the drain system open while transporting the boat or performing other maintenance.
6. Reinstall the blue drain plug in the thermostat housing.
7. Close the drain system by rotating the blue handle clockwise until it stops and install the blue drain plug, if removed. The handle is fully seated when no red is visible. Do not overtighten the handle, as this action will create new threads.
8. Open the seacock (if equipped) or unplug and reconnect the water inlet hose before operating the engine.

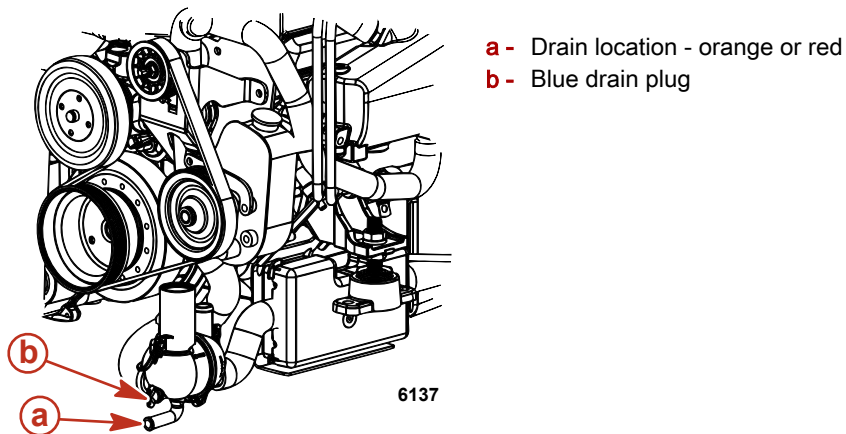
Boat Out of the Water

1. Place the boat on a level surface to ensure complete draining of the system.

2. Rotate the blue handle counterclockwise until it stops (approximately two turns). The red on the handle shaft indicates that the drain system is open. Do not overtighten the handle, as this action will create new threads.



3. Visually verify that water is draining. If water does not drain, remove the blue drain plug from the distribution housing and drain manually.



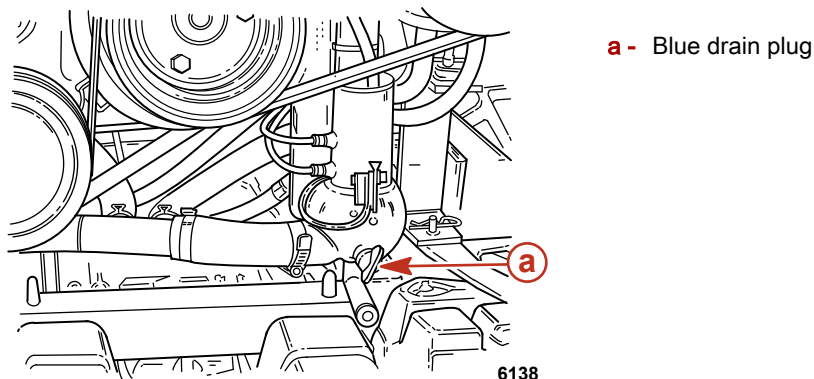
4. Allow the system to drain for a minimum of five minutes. We recommend leaving the plugs out while transporting the boat or performing other maintenance to ensure that all water is drained.
5. Close the drain system by rotating the blue handle clockwise until it stops or installing the blue drain plug. The handle is fully seated when no red is visible. Do not overtighten the handle, as this action will create new threads.

Three-Point Manual Drain System

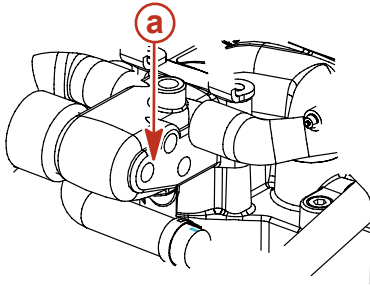
Boat in the Water

NOTE: Use this procedure if your engine is not equipped with an air actuated single-point drain system or if the air actuated single-point drain system fails.

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the blue drain plug from the distribution housing (lower front, port side).

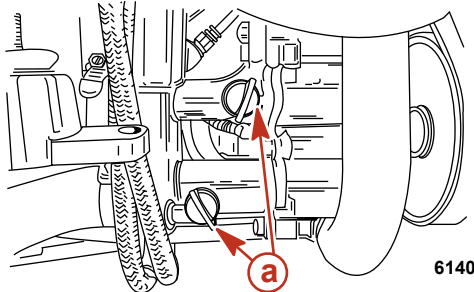


- To properly vent the cooling system, remove the blue drain plug from the side of the thermostat housing within 30 seconds.



a - Blue drain plug location

- Remove the two blue drain plugs from the seawater pickup pump (front, starboard side).



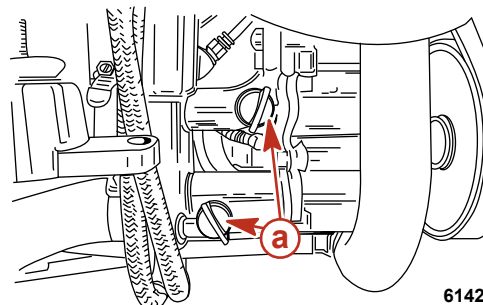
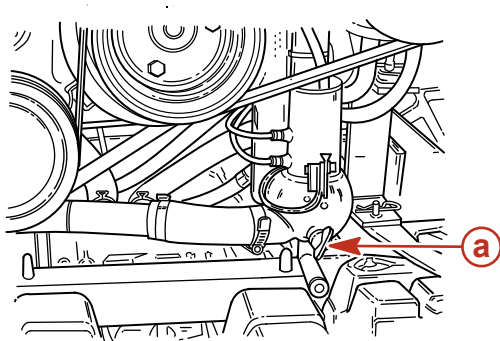
a - Blue drain plugs (2)

- Verify that water is draining from each opening.
- Allow the system to drain for a minimum of five minutes. We recommend leaving the drain system open while transporting the boat or performing other maintenance to ensure that all water is drained.
- Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pickup pump. Do not allow the engine to start.
- Before launching the boat or starting the engine, close the drain system by installing the four blue drain plugs.
- Open the seacock, if equipped, or unplug and reconnect the water inlet hose prior to operating the engine.

Boat Out of the Water

NOTE: Use this procedure if your engine is not equipped with an air actuated single-point drain system or if the single-point drain system fails.

- Place the boat on a level surface to ensure complete draining of the system.
- Remove three blue drain plugs: one from the distribution housing (lower front, port side) and two from the seawater pickup pump (front, starboard side).



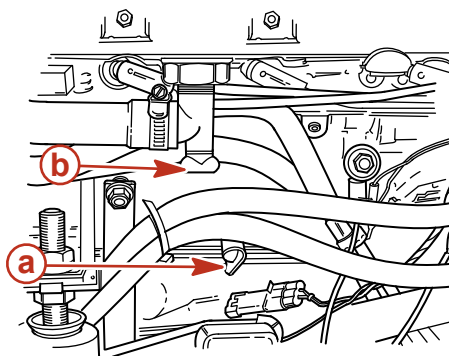
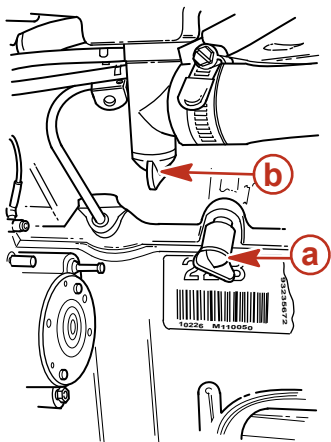
a - Blue drain plug (3)

- Verify that water is draining from each opening.
- Allow the system to drain for a minimum of five minutes. We recommend leaving the drain system open while transporting the boat or performing other maintenance to ensure that all water is drained.
- Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pickup pump. Do not allow the engine to start.
- Before launching the boat or starting the engine, close the drain system by installing the three blue drain plugs.

Multipoint Drain (MPD) System

Boat in the Water

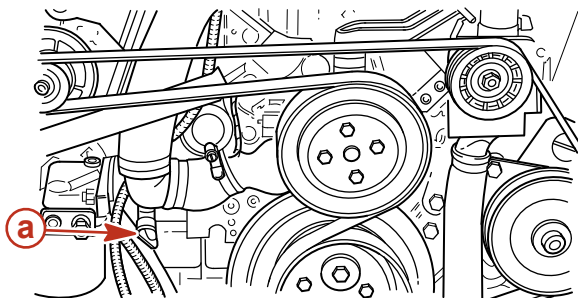
1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the blue drain plugs from the following locations. If necessary, clean out the drain holes using a stiff piece of wire. Do so until the entire system is drained.
 - a. Port and starboard side of cylinder block
 - b. Bottom of exhaust manifolds



- a** - Side of cylinder block (2)
- b** - Bottom of exhaust manifolds (2)

6129

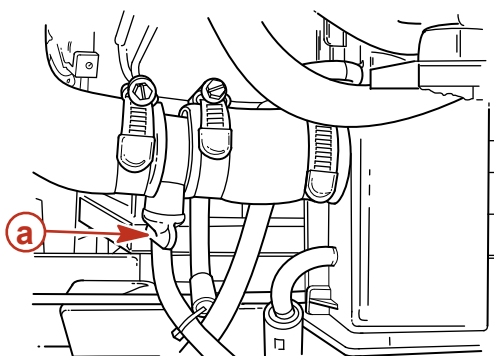
- c. Water-circulating pump hose



- a** - Drain plug

6143

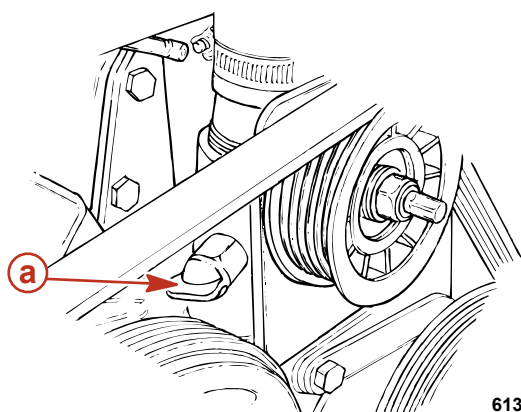
- d. Fuel cooler-to-thermostat housing hose (MPI models)



- a** - Drain plug

6144

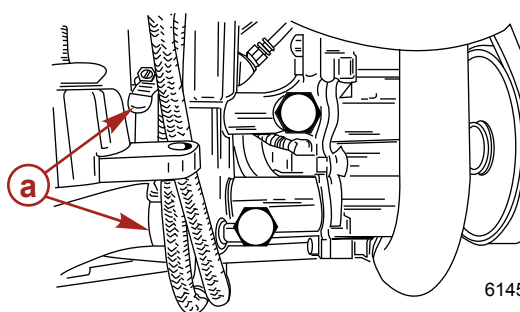
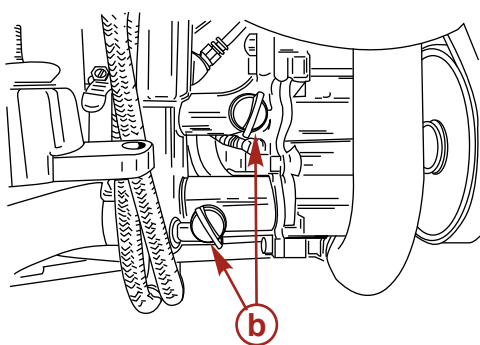
e. Check valve



a - Drain plug (if equipped)

6131

3. On models with a seawater pickup pump, remove the two blue drain plugs. If the seawater pickup pump does not have blue drain plugs, or you are unable to access them, loosen the clamps and remove both hoses.



6145

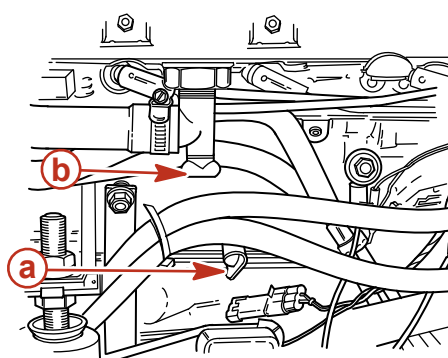
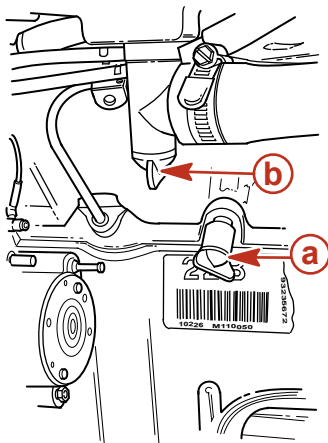
a - Hose clamps

b - Blue drain plugs

4. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pickup pump. Do not allow the engine to start.
5. Before launching the boat or starting the engine, close the drain system by installing the blue drain plugs.
6. Open the seacock, if equipped, or unplug and reconnect the water inlet hose before operating the engine.

Boat Out of the Water

1. Place the boat on a level surface to ensure complete draining of the system.
2. Remove the blue drain plugs from the following locations. If necessary, clean out the drain holes using a stiff piece of wire.
 - a. Port and starboard side of cylinder block
 - b. Bottom of exhaust manifolds

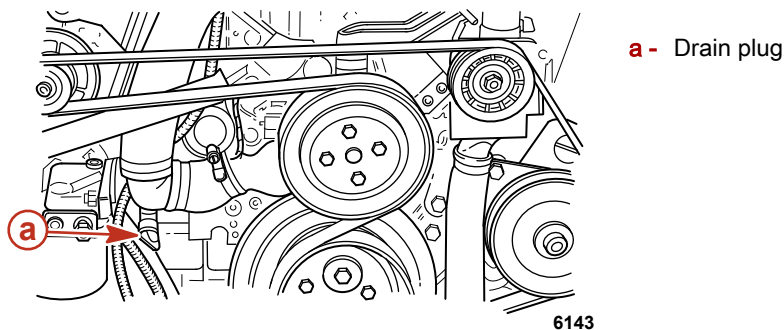


a - Side of cylinder block (2)

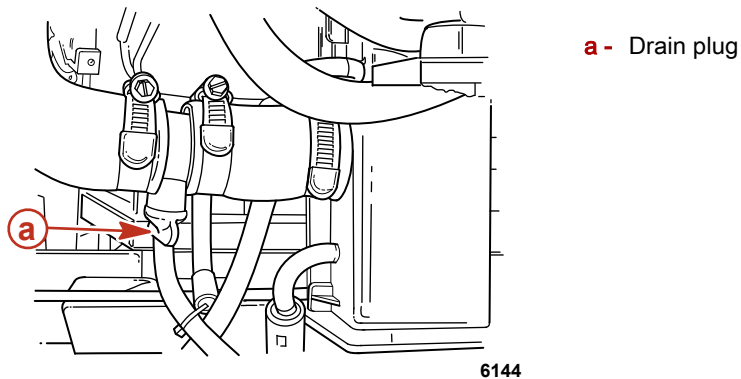
b - Bottom of exhaust manifolds (2)

6129

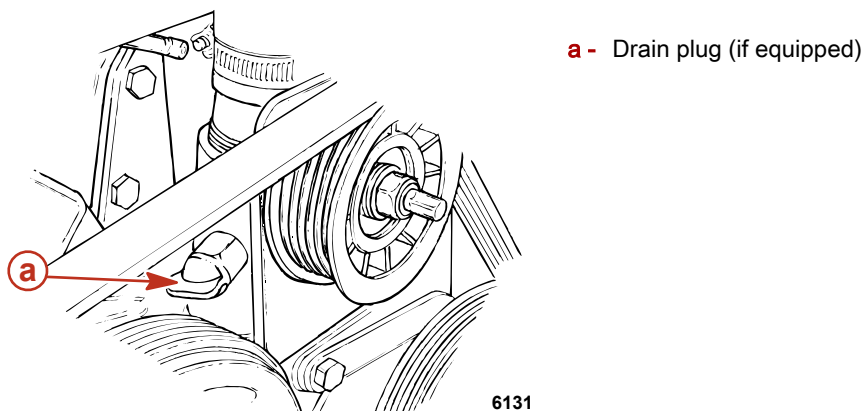
c. Water-circulating pump hose



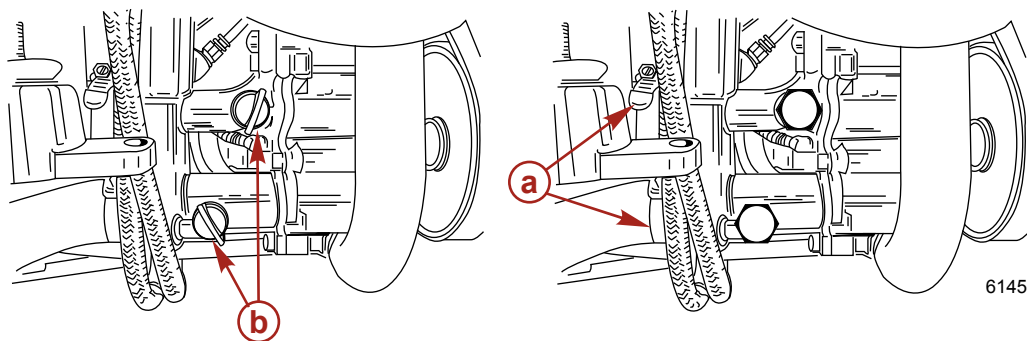
d. Fuel cooler-to-thermostat housing hose (MPI models)



e. Check valve



3. On models with a seawater pickup pump, remove the two blue drain plugs. If the seawater pickup pump does not have blue drain plugs, or you are unable to access them, loosen the clamps and remove both hoses.



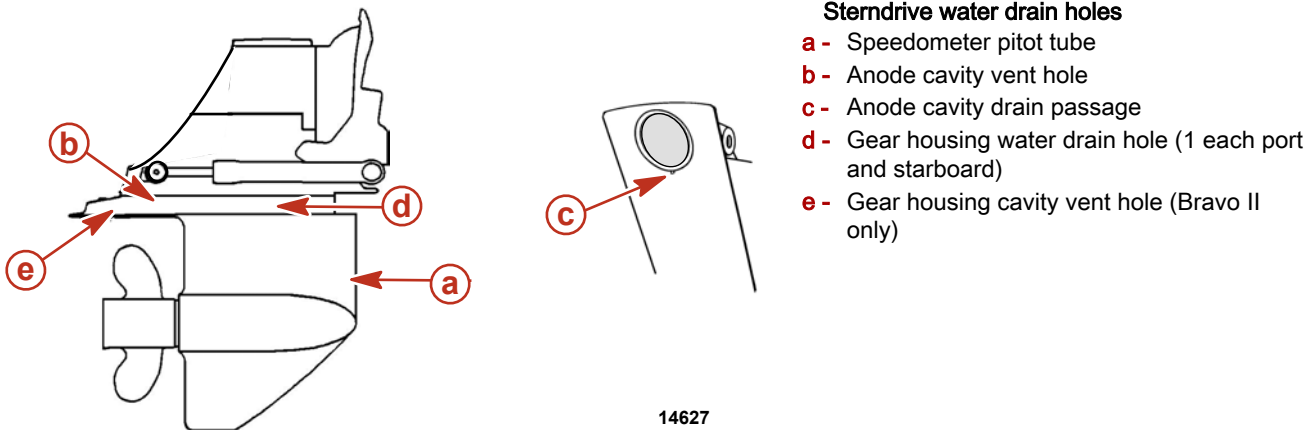
- a - Hose clamps
- b - Blue drain plugs

4. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pickup pump. Do not allow the engine to start.
5. After the cooling system has been drained completely, install the drain plugs, reconnect the hoses, and tighten all hose clamps securely.

Draining the Sterndrive

NOTE: This procedure is needed only for saltwater, brackish water, mineral-laden water, or polluted water applications; and for freezing temperatures or extended storage.

1. Insert a small wire repeatedly to ensure that the vent holes, water drain holes, and passages are unobstructed and open.



NOTICE

The universal joint bellows may develop a set when stored in a raised or up position, causing the bellows to fail when returned to service and allowing water to enter the boat. Store the sterndrive in the full down position.

2. Lower the sterndrive to the full down/in position.
3. For additional assurance against freezing and rust, after draining, fill the cooling system with propylene glycol mixed to the manufacturer's recommendation to protect the engine to the lowest temperature to which it will be exposed during freezing temperatures or extended storage
IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Flushing the Seawater System—Sterndrive Models

General Information—Bravo Sterndrive

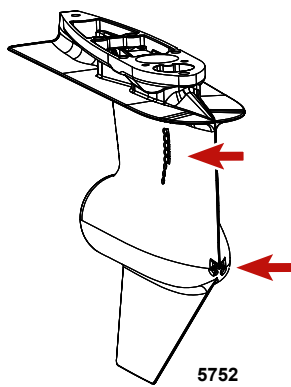
Your boat could be equipped with a combination of any of three different types of water pickups: through-the-hull, through-the-transom, and through-the-sterndrive. The flushing procedures for these systems are separated into two categories: sterndrive water pickups and alternative water pickups.

Flushing Attachments

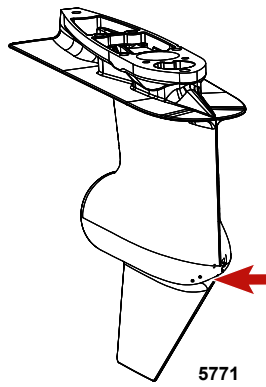
Flushing Device	91-44357Q 2
Dual Water Pickup Flush Gearcase Seal Kit	91-881150K 1
Flushing Kit	91-849996T 1

Sterndrive Water Pickups

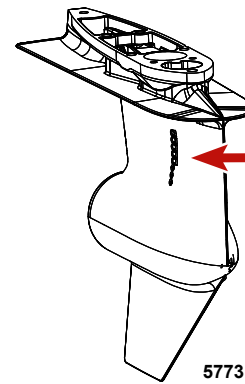
There are three types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water, and side pickups. Dual water pickups require the flushing attachment (44357Q 2) and the flush seal kit (881150K 1), low water pickups require the flushing attachment (849996T 1), and side pickups require the flushing attachment (44357Q 2).



Dual water pickup



Low water pickup



Side pickup

Boat Out of the Water—Bravo Sterndrive

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results, flushing is recommended after each outing and before cold weather and extended storage.

1. Lower the sterndrive to full down/in position.

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

2. Remove the propeller. Refer to the appropriate Mercury MerCruiser sterndrive service manual.
3. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
4. Connect the water supply hose to the water source.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

5. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
6. Place the remote control in the neutral idle speed position.
7. Immediately start the engine.

NOTICE

Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

8. Press the throttle only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
9. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
10. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
11. **For power packages operated in saltwater, brackish water, mineral-laden water, or polluted water,** continue to operate the engine until the discharge water is clear.
12. Slowly return the throttle to idle speed position.
13. Stop the engine.
14. Immediately shut off the supply water and remove the flushing attachment.

15. Install the propeller. Refer to the appropriate Mercury MerCruiser sterndrive service manual.

Boat in the Water—Bravo Sterndrive

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results, flushing is recommended after each outing and before cold weather and extended storage.

1. Raise the sterndrive to the trailer position.
2. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
3. Lower the sterndrive to the full down/in position.
4. Connect the water supply hose to the water source.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

5. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
6. Place the remote control in the neutral idle speed position.
7. Immediately start the engine.
8. Press the throttle only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).
9. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
10. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
11. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water,** continue to operate the engine until the discharge water is clear.
12. Slowly return the throttle to the idle speed position.
13. Stop the engine.
14. Immediately shut off the supply water. Do not remove the flushing attachment from the sterndrive at this time.

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

15. Close the seacock, if equipped, then disconnect the seawater inlet hose to prevent water from siphoning into the engine or boat.
16. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump, and immediately plug the hose to prevent water from siphoning into the engine or boat.
17. Raise the sterndrive to the trailer position.
18. Remove the flushing attachment from the sterndrive.
19. Tag the ignition switch with an appropriate tag requiring the seacock to be opened or the seawater inlet hose to be reconnected before operating the engine.

Boat Out of the Water—Alternative Water Pickups

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results flushing is recommended after each outing and before cold weather and extended storage.

1. Lower the sterndrive to the full down/in position.

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

2. Remove the propeller. Refer to the appropriate Mercury MerCruiser sterndrive service manual.
3. Close the seacock, if equipped.
4. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump.
5. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

6. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
7. Place the remote control in the neutral idle speed position.
8. Immediately start the engine.

NOTICE

Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

9. Press the throttle only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
12. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
13. Slowly return the throttle to the idle speed position.
14. Stop the engine.
15. Immediately shut off the supply water and remove the flushing attachment.
16. Install the water inlet hose to the seawater inlet of the seawater pump. Tighten the hose clamp securely.
17. Install the propeller. Refer to the appropriate Mercury MerCruiser sterndrive service manual.

Boat in the Water—Alternative Water Pickups

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results flushing is recommended after each outing and before cold weather and extended storage.

1. Lower the sterndrive to the full down/in position.

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

2. Close the seacock, if equipped, then disconnect the seawater inlet hose to prevent water from siphoning into the engine or boat.
3. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump and immediately plug the hose to prevent water from siphoning into the engine or boat.
4. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

5. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
6. Place the remote control in the neutral idle speed position.
7. Immediately start the engine.

NOTICE

Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

8. Press the throttle only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).
9. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
10. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
11. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
12. Slowly return the throttle to the idle speed position.

13. Stop the engine.
14. Immediately shut off the supply water and remove the flushing attachment.
15. Tag the ignition switch with an appropriate tag requiring the seacock to be opened or the seawater inlet hose to be reconnected before operating the engine.

Cold Weather or Extended Storage

IMPORTANT: Mercury MerCruiser strongly recommends that this service should be performed by an authorized Mercury MerCruiser dealer. Damage caused by freezing is not covered by the Mercury MerCruiser Limited Warranty.

NOTICE

Water trapped in the seawater section of the cooling system can cause corrosion or freeze damage. Drain the seawater section of the cooling system immediately after operation or before any length of storage in freezing temperatures. If the boat is in the water, keep the seacock closed until restarting the engine to prevent water from flowing back into the cooling system. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged.

NOTE: As a precautionary measure, attach a tag to the key switch or steering wheel of the boat reminding the operator to open the seacock or unplug and reconnect the water inlet hose before starting the engine.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (a nontoxic antifreeze) be used in the seawater section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Preparing Power Package for Storage

1. Fill the fuel tanks with fresh gasoline (that does not contain alcohol) and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat the gasoline. Follow instructions on the container.
2. If the boat is to be placed in storage with fuel containing alcohol in the fuel tanks (if fuel without alcohol is not available): Fuel tanks should be drained as low as possible and Mercury/Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to **Fuel Requirements** in **Section 1A** for additional information.
3. Flush the cooling system. Refer to **Flushing the Power Package** in this section.
IMPORTANT: In order to run the engine as required in the remainder of the storage preparation procedure, water must be supplied to the engine as described in the flushing procedure.
4. Provide cooling water to the engine as done in the previous step.
5. Operate the engine sufficiently to bring it up to normal operating temperature and allow fuel with Mercury/Quicksilver Gasoline Stabilizer to circulate through the fuel system. Shut off the engine.
6. Change the oil and oil filter.
7. Prepare the engine and fuel system for storage. Refer to **Engine and Fuel System Preparation**.
8. Drain the engine seawater cooling system. Refer to **Draining the Seawater System**.

NOTICE

Water trapped in the seawater section of the cooling system can cause corrosion or freeze damage. Drain the seawater section of the cooling system immediately after operation or before any length of storage in freezing temperatures. If the boat is in the water, keep the seacock closed until restarting the engine to prevent water from flowing back into the cooling system. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged.

9. Ensure that the sterndrive vent holes and water drain holes and passages are unobstructed and open. Refer to **Draining the Sterndrive** in this section.
10. For additional assurance against freezing and rust, after draining, fill the cooling system with propylene glycol mixed to the manufacturer's recommendation to protect the engine to the lowest temperature to which it will be exposed during freezing temperatures or extended storage.

NOTICE

The universal joint bellows may develop a set when stored in a raised or up position, causing the bellows to fail when returned to service and allowing water to enter the boat. Store the sterndrive in the full down position.

11. Store the boat with the drive unit in full down/in position.
12. Store the battery according to the manufacturer's instructions.

Engine and Fuel System Preparation—MPI Models

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

⚠ WARNING

Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

1. In a 23 Liter (6 US gal) remote fuel tank mix:
 - a. 19 Liter (5 US gal) of regular unleaded 87 octane (90 RON) gasoline.
 - b. 1.89 Liter (2 US qt) of Premium Plus 2-Cycle TC-W3 Outboard Oil.
 - c. 150 mL (5 oz) of Fuel System Treatment and Stabilizer, or 30 mL (1 oz) of Fuel System Treatment and Stabilizer Concentrate.

Tube Ref No.	Description	Where Used	Part No.
 115	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
 124	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

2. Allow the engine to cool down.
IMPORTANT: Immediately wipe up any fuel spills or sprays.
3. Close the fuel shut off valve, if equipped. Disconnect and plug the fuel inlet fitting if not equipped with a fuel shut off valve.
4. Connect the remote fuel tank (with the fogging mixture) to the fuel inlet fitting.
IMPORTANT: Supply cooling water to the engine.
5. Start and operate the engine at 1300 RPM for five minutes.
6. After specified operating time is complete, slowly return throttle to idle RPM and shut engine off.
IMPORTANT: Ensure that some fogging mixture remains in the engine. Do not allow the engines fuel system to become completely dry.
7. Replace the water separating fuel filter element. Refer to **Section 5** for proper procedure.

Engine and Fuel System Preparation—TKS Carbureted Models

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

⚠ WARNING

Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

1. Prepare carbureted fuel system for extended storage as follows:
 - a. Start the engine.
 - b. Provide cooling water to the engine as done in the previous step.
 - c. Remove the flame arrestor assembly.
 - d. Close the fuel shut off valve, if equipped. Disconnect and plug the fuel inlet fitting if not equipped with a fuel shut off valve.
 - e. While operating the engine at fast idle (1300 RPM), fog the internal surfaces of the induction system and combustion chambers by spraying approximately 227 g (8 oz) of Mercury/Quicksilver Storage Seal Rust Inhibitor, or SAE 20W engine oil into the carburetor bores.

- f. Spray the remaining 57 g (2 oz) of Storage Seal Rust Inhibitor (or oil) rapidly into the carburetor, just as the engine begins to stall, due to lack of fuel. Allow the engine to stop.

Tube Ref No.	Description	Where Used	Part No.
 119	Storage Seal Rust Inhibitor	Carburetor	92-858081K03

- g. Turn ignition key to "OFF" position.

Battery Storage

Whenever the battery will be stored for an extended period of time, be sure the cells are full of water and the battery is fully charged and in good operating condition. It should be clean and free of leaks. Follow the battery manufacturer's instructions for storage.

Power Package Recommissioning

1. Ensure that all cooling system hoses are connected properly and hose clamps are tight.

CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

2. Install a fully charged battery. Clean the battery cable clamps and terminals and reconnect cables (see CAUTION listed above). Tighten each cable clamp securely when connecting.
3. Coat the terminal connections with a battery terminal anti-corrosion agent.
4. Perform all the checks in the **Before Starting** column of the **Operations Chart** found in the appropriate Owner's and Operation manual.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

5. Start the engine and closely observe instrumentation to ensure that all systems are functioning correctly.
6. Carefully inspect the engine for fuel, oil, fluid, water, and exhaust leaks.
7. Inspect the steering system, shift and throttle control for proper operation.

Notes:

Important Information

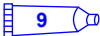
Section 1D - Troubleshooting

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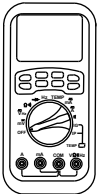
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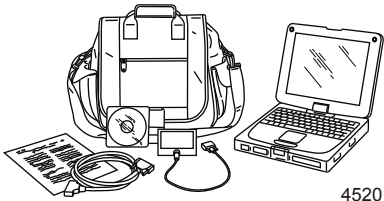
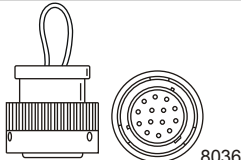
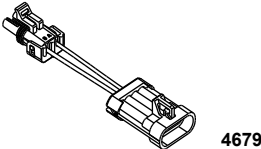
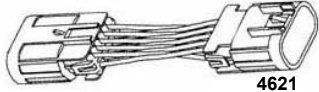
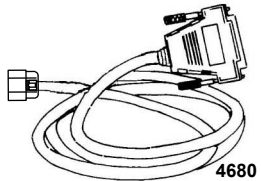
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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Sender threads	92-809822
 25	Liquid Neoprene	Electrical connections	92- 25711 3
		Electrical connection	

Special Tools

Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system and can be used in conjunction with Computer Diagnostic System (CDS).
DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.
Idle Mixture Adjusting Tool	91-866201
 9668	Used to perform idle adjustments on the TKS carburator
CDS G3 Diagnostic Interface Tool With Harness	8M0046124
 41993	Provides diagnostic support for the Computer Diagnostic System.

Computer Diagnostic System (CDS)	Available through Bosch Automotive Service Solutions
	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: Bosch Automotive Service Solutions 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222
12-volt connector tool, PCM/ECM Wake-up	91-889675A01
	Connects to the data harness, allowing operation of the DTS system with the Digital Diagnostic Terminal or CDS.
2- to 4-pin harness adapter	84-822560A12
	Adapts the 2-pin digital diagnostic terminal harness to the 4-pin connector on the engine.
Adapter harness	84-822560A13
	Data link harness between engine and Computer Diagnostic System (CDS).
Male-to-male 10-pin adapter	84-892452A01
	Allows connection between the CAN 1 communications cable and Computer Diagnostic System in applications where a junction box is not used.
CAN 1 diagnostic cable	84-892663
	Connects into a junction box or male to male adapter cable for Command Module configuration. Not for use with DDT.
Breakout box	P/N MM-46225 (Available through Bosch Automotive Service Solutions)
	Connects to the propulsion control module (PCM) to test engine circuits and components without probing wires. May be used with computer diagnostic system (CDS).

Terminal test probe kit	P/N MM-46523 (Available through Bosch Automotive Service Solutions)
 7915	Test probes adapt test meter leads to harness connections without damaging harness terminals. May be used with the computer diagnostic system (CDS).

Important Information

Precautions

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

⚠ WARNING

Performing tests with the engine running may cause the propeller to rotate and result in serious injury or death. Use caution when performing a test that requires the engine running, and remove the propeller to avoid injury.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

NOTICE

Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

⚠ WARNING

Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

Overload Protection

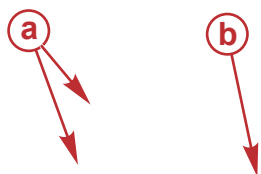
IMPORTANT: If all instruments are inoperative an electrical overload may have blown a fuse or tripped a circuit breaker. The cause of the overload must be corrected before returning the boat to service.

The initial investigation into instrumentation malfunctions should begin with the following:

- Confirm that the battery is fully charged.
- Check all fuses and circuit breakers.
- Inspect for wiring damage and loose or broken connectors.
- Ensure that all wiring connectors are properly connected and free of corrosion.

Fuses

4.3L MPI engines - Four fuses protect the main power, fuel pump, ignition, and accessory circuits. These are located on the top of the engine below the PCM connectors.

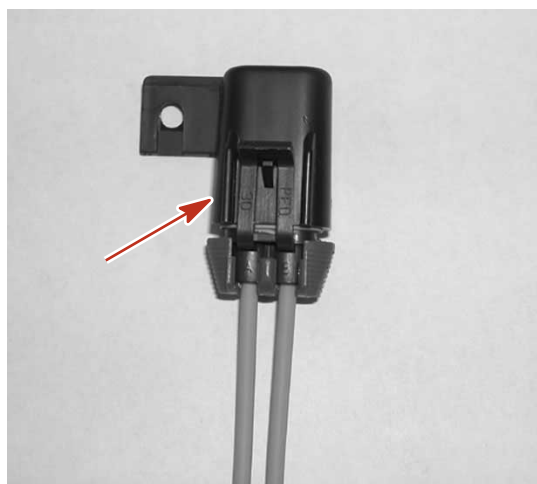


4.3L MPI

- a** - Fuses
- b** - 50-amp circuit breaker

49258

4.3L TKS engines - A 15-amp accessory fuse is located on the rear of the engine. This fuse protects the accessory circuits. A 20-amp fuse located below the shift bracket on the starboard side of the engine protects the TKS module.



7524

15-amp accessory fuse (20-amp fuse similar)

Audio Warning System

MerCruiser 4.3L TKS and 4.3L MPI power packages are equipped with an audio warning system. The audio warning system will not protect the engine from damage. It is designed to warn the operator that a problem has occurred.

The audio warning system will sound with a continuous horn if one of the following occurs:

- Engine oil pressure is too low
- Engine temperature is too hot
- Sterndrive oil level is too low

NOTICE

A continuous horn indicates a critical fault. Operating the engine during a critical fault can damage components. If the warning horn emits a continuous beep, do not operate the engine unless avoiding a hazardous situation.

If the alarm sounds, stop the engine immediately. Investigate the cause and correct it, if possible. If the cause cannot be determined, contact your authorized Mercury MerCruiser dealer.

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.

2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Guardian Strategy

The MerCruiser Engine Guardian system reduces the potential for engine damage by restricting engine power when the PCM detects a potential problem. Below are some examples of what Engine Guardian monitors:

- Oil pressure
- Engine overspeed
- Water pressure (sea pump)

IMPORTANT: Engine Guardian can reduce power anywhere from 100% to idle, depending on the severity of the problem. If forced to idle, boat speed might not respond to throttle operation.

The ECM stores the fault for diagnostics. For example, if the water inlet becomes partially blocked, Engine Guardian reduces the available power level of the engine to help prevent damage from overheating due to decreased water flow to the engine. If the debris passes through, and full water flow is restored, Engine Guardian restores engine power to normal.

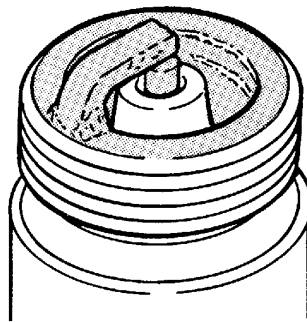
Used Spark Plug Analysis

Spark plug condition can suggest a variety of possible engine malfunctions and indicate needed engine repairs. When the old plugs are replaced, replace the entire set. Perform plug service only on those plugs suitable for additional service using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open the electrode gap wide enough to permit cleaning and filing.
3. Remove the combustion deposits from the firing end of the spark plug with a plug cleaner. Use compressed air to remove abrasives.
4. File the electrode surfaces to restore clean, sharp edges. Remove filings with compressed air.
5. Reset the gap to specifications by bending only the side electrode with the proper tool.

Normal Condition

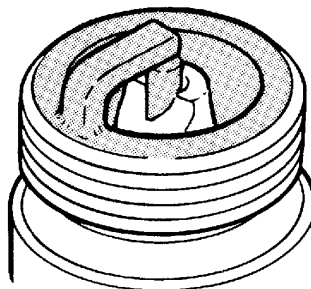
Few deposits are present and probably will be light tan or gray in color. This plug shows that the plug heat range is compatible with the engine, and the engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file, and regap), this plug can be reinstalled with good results.



27643

Chipped Insulator

A chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split the insulator firing ends. Replace the spark plugs.

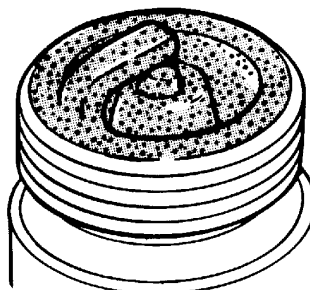


27644

Wet Fouling (Oil Deposits)

The plug becomes shorted by excessive oil entering the combustion chamber, usually in the engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering the combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

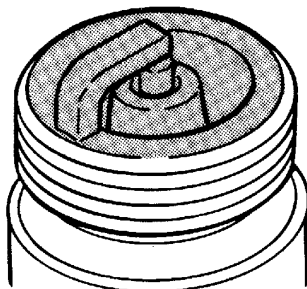
IMPORTANT: New engines or recently overhauled engines may wet foul the plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file, and regap) and reinstalled.



27645

Cold Fouling

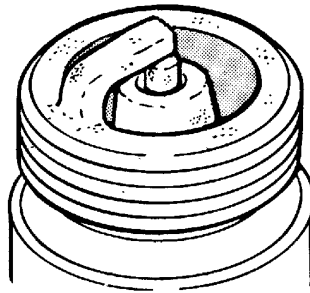
Dry, black deposits indicate a rich fuel mixture or a weak ignition. A clogged flame arrestor, a flooding engine, a sticky choke, or weak ignition components all are probable causes. If, however, only 1 or 2 plugs in the set are fouled, check for sticking valves or bad ignition leads. After correcting the cause, service (clean, file, and regap) plugs and reinstall.



27647

Overheating

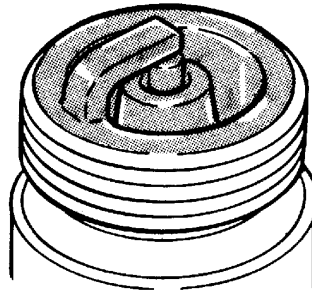
The insulator is dull white or gray and appears blistered. The electrodes are eroded and there is an absence of deposits. Ensure that the correct plug heat range is being used. Also check for incorrect rotor location, cooling system malfunction, lean fuel and air mixtures, leaking intake manifold, or sticking valves. Replace the spark plugs.



27648

High Speed Glazing

The insulator has yellowish, varnish-like color, indicating that the temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace the spark plugs. If the condition recurs, use colder heat range plug and service plugs more frequently.



27649

Scavenger Deposits

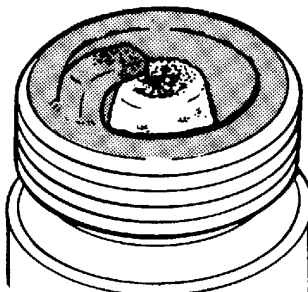
Powdery white or yellow deposits are built up on the shell, the insulator, and the electrodes. This is the normal appearance with certain branded fuels. Accumulation on the ground electrodes and the shell areas may be unusually heavy, but may be easily chipped off. Service (clean, file, and regap) plugs and reinstall.



27650

Pre-Ignition Damage

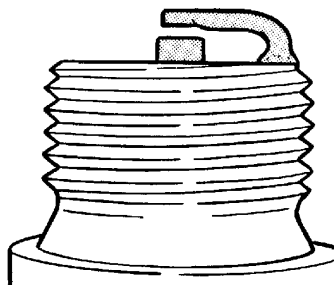
Pre-ignition damage is caused by excessive high temperatures. The center electrode melts first, followed by the ground electrode. Normally, the insulators are white, but may be dirty if the plug has been misfiring. Check for the correct plug heat range, incorrect rotor location, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold, or lack of lubrication. Replace the spark plugs.



27651

Reversed Coil Polarity

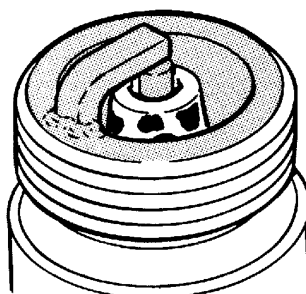
Concave erosion of the ground electrode is an indication of reversed polarity. The center electrode will show only normal wear. The engine will misfire and idle rough. To correct, reverse the primary coil leads. Replace the spark plugs.



27652

Splashed Deposits

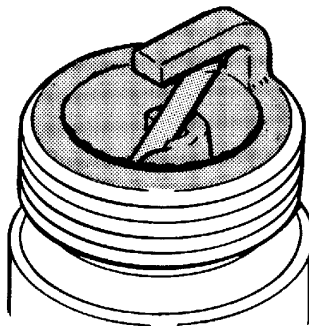
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon the installation of the new plugs, the deposits loosen from the top of the piston and the cylinder head and are thrown against the hot insulator. Service (clean, file, and regap) plugs and reinstall.



27653

Mechanical Damage

Mechanical damage to the spark plug firing end is caused by a foreign object in the combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, the intake manifold and the exhaust material to prevent further damage. Replace the spark plugs.

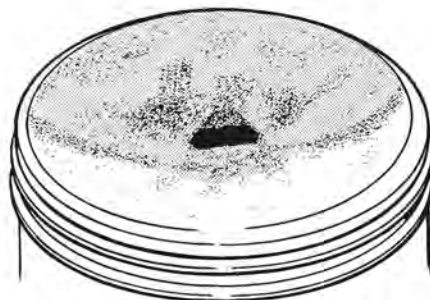
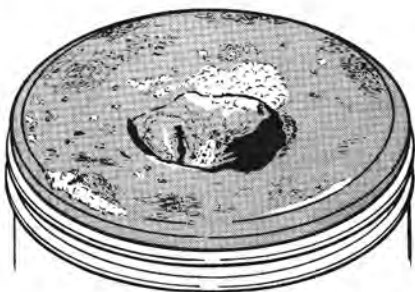


27654

IMPORTANT: When working on the engine, the spark plug holes, the intake and the throttle body should be kept covered to prevent foreign objects from entering the combustion chamber.

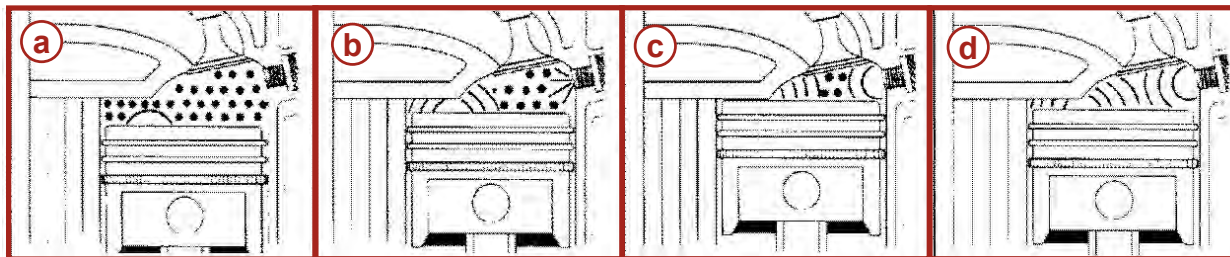
Piston Inspection

1. Replace pistons that are damaged or show signs of excessive wear.
2. Inspect the piston for damage caused by preignition.



14394

Typical preignition damage



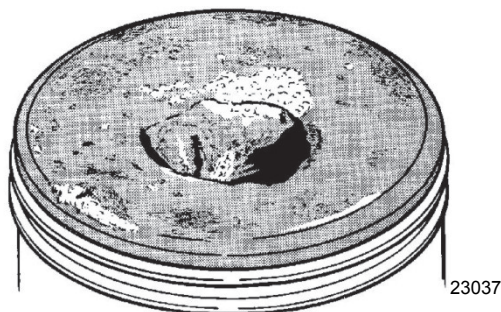
30341

- a - Preignition begins
- b - Controlled ignition spark
- c - Remaining fuel ignition
- d - Flame front collision

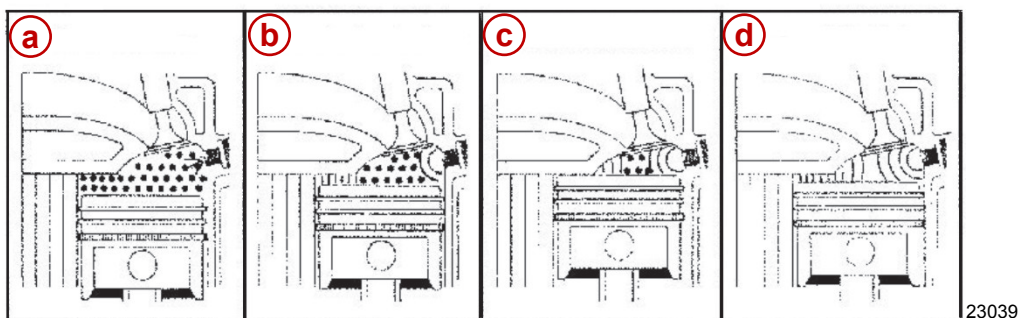
NOTE: Engine failures that result from these conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.

3. If indicated, inspect the engine for causes of preignition damage to pistons:
 - Combustion chamber hot spots caused by damaged components, foreign material, or combustion chamber deposits.
 - Overheated spark plug electrodes (improper heat range or defective plug).

- Inadequate engine cooling.
4. Inspect the piston for damage caused by detonation (knock).



Typical detonation damage



- a** - Controlled ignition spark
- b** - Combustion begins
- c** - Continued combustion
- d** - Detonation occurs

NOTE: The use of poor quality, contaminated, or incorrect fuels will cause poor performance and engine damage.

5. If indicated, inspect the engine for causes of detonation damage to pistons:
- Use of low octane gasoline or neglecting engine maintenance
 - Lean fuel mixture at or near full throttle (could be caused by leaking intake manifold)
 - Cross-firing ignition system
 - The accumulation of deposits on the piston and/or combustion chamber that result in a higher compression ratio
 - Inadequate engine cooling

NOTE: Engine failures that result from these conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.

Starter Motor Will Not Crank Engine, or Cranks Slowly

Possible Cause	Remedy
Battery switch turned off.	Turn the switch on.
Remote control not in neutral position.	Position the control lever in neutral.
Open circuit breaker or fuse.	Check and reset the main power circuit breaker or replace the fuse. Check the 5-amp fuse on the power harness connected to the battery, and replace if necessary. Inspect the corresponding circuit to determine the cause of failure.
Loose or dirty electrical connections or damaged wiring.	Check all electrical connections and wires (especially battery cables). Clean and tighten all faulty connections.
Bad battery or low battery voltage.	Test the battery and charge if necessary; replace if bad.
Lanyard stop switch activated.	Check the lanyard stop switch.

Engine Will Not Start or Is Hard to Start

Possible Cause	Remedy
Lanyard stop switch activated.	Reset the lanyard stop switch.
Improper starting procedure.	Read and follow the starting procedure.
Insufficient fuel supply.	Fill the fuel tank or open valve.
Faulty ignition system component.	Service the ignition system.
Clogged fuel filter.	Replace fuel filter.
Stale or contaminated fuel.	Drain the fuel tank. Fill with fresh fuel.
Fuel line or tank vent line kinked or clogged.	Replace kinked lines or blow out lines with compressed air to remove obstruction.
Faulty wire connections.	Check wire connections.
MPI system fault.	Check the fuel system. Refer to Section 5C .

Engine Runs Rough, Misses, or Backfires

Possible Cause	Remedy
Clogged fuel filter.	Replace the fuel filter.
Stale or contaminated fuel.	Drain the fuel tank. Fill with fresh fuel.
Kinked or clogged fuel line or fuel tank vent line.	Replace kinked lines or blow out lines with compressed air to remove obstruction.
Flame arrestor dirty.	Clean the flame arrestor.
Faulty ignition system component.	Service the ignition system.
Idle speed too low.	Check the fuel system. Refer to Section 5A .
MPI system fault.	Check the fuel system. Refer to MerCruiser ECM Fault Information and Troubleshooting .

Poor Performance

Possible Cause	Remedy
Throttle not fully open.	Inspect the throttle cable and linkages for proper operation.
Damaged or improper propeller.	Replace the propeller.
Excessive bilge water.	Drain and check for cause of entry.
Boat overloaded or load improperly distributed.	Reduce load or redistribute load more evenly.
Flame arrestor dirty.	Clean the flame arrestor.
Boat bottom fouled or damaged.	Clean or repair as necessary.
Ignition problem.	Refer to Engine Runs Rough, Misses, or Backfires .
Engine overheating.	Refer to Engine Overheat .
MPI system fault.	Check the fuel system. Refer to MerCruiser ECM Fault Information and Troubleshooting .

Engine Overheat

Possible Cause	Remedy
Water inlet or seacock closed.	Open the inlet or seacock.
Drive belt loose or in poor condition.	Replace or adjust belt.
Seawater pickups or sea strainer obstructed.	Remove obstruction.
Faulty thermostat.	Replace the thermostat.
Coolant level (if equipped) low in the closed-cooling section.	Check for cause of low coolant level and repair. Fill system with proper coolant solution.

Possible Cause	Remedy
Heat exchanger or fluid cooler plugged with foreign material.	Clean heat exchanger, engine oil cooler, and transmission oil cooler (if equipped).
Loss of pressure in the closed-cooling section.	Check for leaks. Clean, inspect, and test the pressure cap.
Faulty seawater pickup pump.	Repair.
Seawater discharge restricted or plugged.	Clean exhaust elbows.

Low Engine Temperature

Possible Cause	Remedy
Faulty thermostat.	Replace the thermostat.

Low Engine Oil Pressure

Possible Cause	Remedy
Insufficient oil in the crankcase.	Check and add oil.
Excessive oil in the crankcase (causing it to become aerated).	Check and remove the required amount of oil. Check for the cause of excessive oil (improper filling).
Diluted or improper viscosity oil.	Change the oil and oil filter, using the correct grade and viscosity oil. Determine the cause for dilution (excessive idling).

Battery Will Not Recharge

Possible Cause	Remedy
Excessive current draw from battery.	Turn off non-essential accessories.
Alternator drive belt loose or in poor condition.	Replace or adjust.
Unacceptable battery condition.	Test battery, replace if necessary.
Loose or dirty electrical connections or damaged wiring.	Check all associated electrical connections and wires (especially battery cables). Clean and tighten faulty connections. Repair or replace damaged wiring.
Faulty alternator	Test alternator output, replace if necessary.

Remote Control Is Difficult to Move, Has Excessive Play, or Makes Unusual Sounds

Possible Cause	Remedy
Insufficient lubrication on shift and throttle linkage fasteners.	Lubricate.
Obstruction in shift or throttle linkages.	Remove obstruction.
Loose or missing shift and throttle linkages.	Check all throttle and shift linkages. If any are loose or missing, replace or repair them immediately. For throttle linkage, refer to Section 5 in this manual. For shift problems refer to the appropriate MerCruiser sterndrive manual.
Shift or throttle cable kinked.	Straighten cable or replace the cable if damaged beyond repair. For throttle linkage, refer to Section 5 in this manual. For shift problems refer to the appropriate MerCruiser sterndrive manual.

Steering Wheel Jerks or Is Difficult to Turn

Possible Cause	Remedy
Low power steering pump fluid level.	Check for leak. Refill system with fluid.
Drive belt loose or in poor condition.	Replace or adjust.
Insufficient lubrication on steering components.	Lubricate.
Loose or missing steering fasteners or parts.	Check all parts and fasteners; if any are loose or missing, tighten or replace.

Troubleshooting

Possible Cause	Remedy
Contaminated power steering fluid.	Identify source of contamination; correct; and change power steering fluid.

Power Trim Does Not Operate (Motor Does Not Operate)

Possible Cause	Remedy
Blown fuse.	Replace the fuse. Fuses may be located near the dash trim switch, at the trim pump, in the positive (red) power trim battery lead near the battery switch, or a combination of these.
Loose or dirty electrical connections or damaged wiring.	Check all associated electrical connections and wires (especially battery cables). Clean and tighten faulty connection. Repair or replace wiring.

Power Trim Does Not Operate (Motor Operates but Sterndrive Unit Does Not Move)

Possible Cause	Remedy
Trim pump oil level is low.	Fill the pump with oil.
Drive unit is binding in the gimbal ring.	Check for an obstruction.

Troubleshooting Shift Problems

If hard shifting, chucking, or ratcheting is encountered when shifting into forward gear, refer to the remote control manual or to the appropriate sterndrive service manual for troubleshooting information.

Engine Noise

No definite rule or test will positively determine the source of engine noise. Use the following information as a general guide to diagnose engine noise.

1. Use a timing light to determine if the noise is timed with engine speed or $\frac{1}{2}$ engine speed. Noises timed with engine speed are related to the crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to $\frac{1}{2}$ engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, exercise caution.

Description	Part Number
Stethoscope	Obtain locally

3. Try to isolate the noise to a location in the engine: front to back, top to bottom. This can help determine which components are at fault.
4. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are the flywheel or coupler; the exhaust flappers rattling against the exhaust pipe; the crankshaft striking the oil pan, oil pan baffle, or dipstick tube; the rocker arm striking the valve cover, or a loose flywheel cover. In many cases, if this is found to be the problem, a complete engine teardown is not necessary.
5. When the noise is isolated to a certain area and component, removal and inspection will be required. See the appropriate sections of the service manual for the information required for service.
6. If the noise cannot be isolated to the engine, remove the drive from the boat. Supply water directly to the engine and, operate the engine without the drive to determine whether the noise still occurs.

Measuring Vacuum

IMPORTANT: Use an accurate digital vacuum gauge that reads in either inches of mercury (in. Hg) or kilopascals (kPa) to check engine vacuum. Dial vacuum gauges are not accurate enough.

Digital Pressure Meter	91-892651A01
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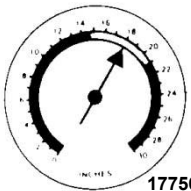
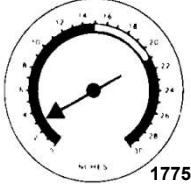
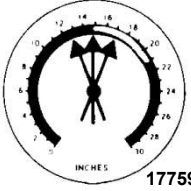
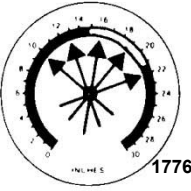
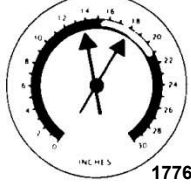
Carefully follow the gauge manufacturer's instructions to ensure accurate vacuum measurement.

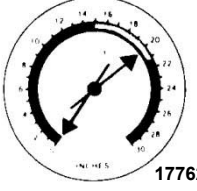
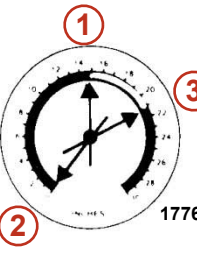
Troubleshooting With a Vacuum Gauge

Most engines have a normal gauge reading of 51–71 kPa (15–21 in. Hg) vacuum. Before using the vacuum gauge the engine must be at normal operating temperature. Use a tachometer to be certain that the engine is running at the specified RPM. The vacuum gauge must be connected to the intake manifold at a manifold vacuum source.

The following table indicates possible malfunctions of various vacuum readings.

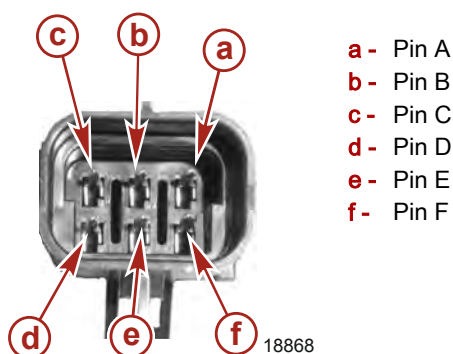
Vacuum Gauge Troubleshooting Guide

Gauge Reading	Symptom	Cause	Action
 17756	Steady reading 51-71 kPa (15-21 in. Hg) at idle RPM	Normal	No action necessary.
 17757	Extremely low reading, but indicator steady at idle RPM	Vacuum leak at intake manifold or carburetor, incorrect timing, or underpowered boat.	Determine the source of the vacuum leak and repair. Replace the propeller. If the problem persists, contact the manufacturer about the correct power package.
 17758	Indicator fluctuates between high and low at idle RPM	Blown cylinder head gasket between two adjacent cylinders. (Check with compression test.)	Determine the cause and replace the cylinder head gasket.
 17759	Indicator fluctuates 13.5-17 kPa (4-5 in. Hg) very slowly at idle RPM	Valves are sticking or spark plug gap is too narrow.	Adjust carburetor. Inspect the spark plugs and service or replace if necessary. Correct sticking valve.
 17760	Indicator fluctuates rapidly at idle, steadies as RPM is increased	Valve guides may be worn.	Ream the valve guides and install a valve with an oversized stem or replace the cylinder head.
 17761	Continuously fluctuates between low and normal reading at regular intervals at idle RPM	Burned or leaking valve.	Replace the valve.

Gauge Reading	Symptom	Cause	Action
	Indicator drops to zero as engine RPM is increased	Exhaust system is restricted.	Clear exhaust system.
	Indicator holds steady at 41–54 kPa (12–16 in. Hg) (1) Drops back to zero (2) and back to about 71 kPa (21 in. Hg) (3) as the throttle is engaged and released	Possible piston ring leak (Check the compression)	Repair or replace as needed.

Sensors, Switches, and Senders

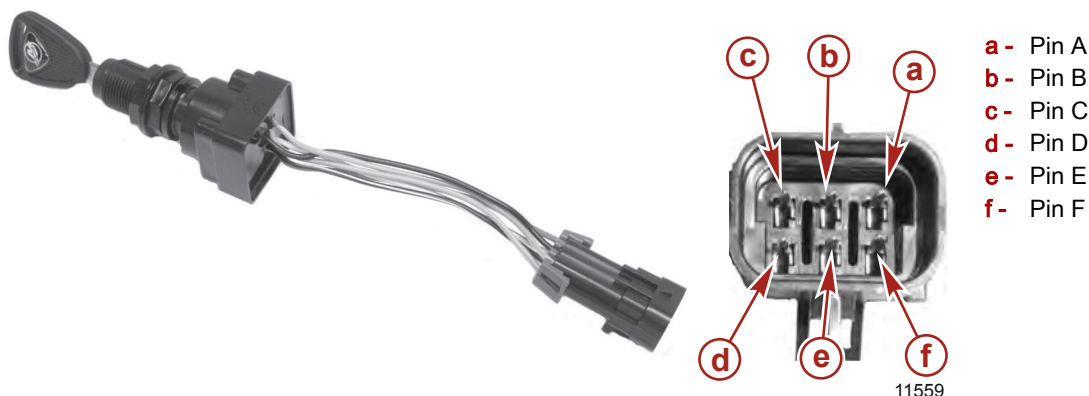
Key Switch Test (Three Position)



Ref. No.	Pin	Wire Color	Description
a	A	Red	12 volts
b	B	Black	Ground
c, d	C, D	Purple	Run
e	E	Black/yellow	Off
f	F	Yellow/red	Start

Meter Test Leads		Key Position	Reading (Ω)
Red	Black		
Pin B	Pin E	Off	Continuity
Pin A	Pin F	Run	Continuity
Pin A	Pin C, D		Continuity
Pin A	Pin F	Start	Continuity
Pin F	Pin C, D		Continuity
Pin A	Pin C, D		Continuity

Key Switch Test (Four Position)



Ref. No.	Pin	Wire Color	Description
a	A	Red	12 volts
b	B	Black	Ground
c	C	Purple/white	Accessory
d	D	Purple	Run
e	E	Black/yellow	Off
f	F	Yellow/red	Start

Meter Test Leads		Key Position	Reading (Ω)
Red	Black		
Pin B	Pin E	Off	Continuity
Pin A	Pin C	Accessories	Continuity
Pin A	Pin F	Run	Continuity
Pin A	Pin C		
Pin A	Pin F	Start	Continuity
Pin F	Pin D		Continuity
Pin A	Pin D		Continuity
Pin A	Pin C		Continuity

Start-Stop Switch Testing

The start-stop switch is a normally open, momentary switch that sends a shutdown signal to the ECM through the ground circuit when the switch is pressed.

1. Disconnect both battery cables from the battery.
2. Check for continuity between the two terminals on the start-stop switch with a continuity meter or DMT.

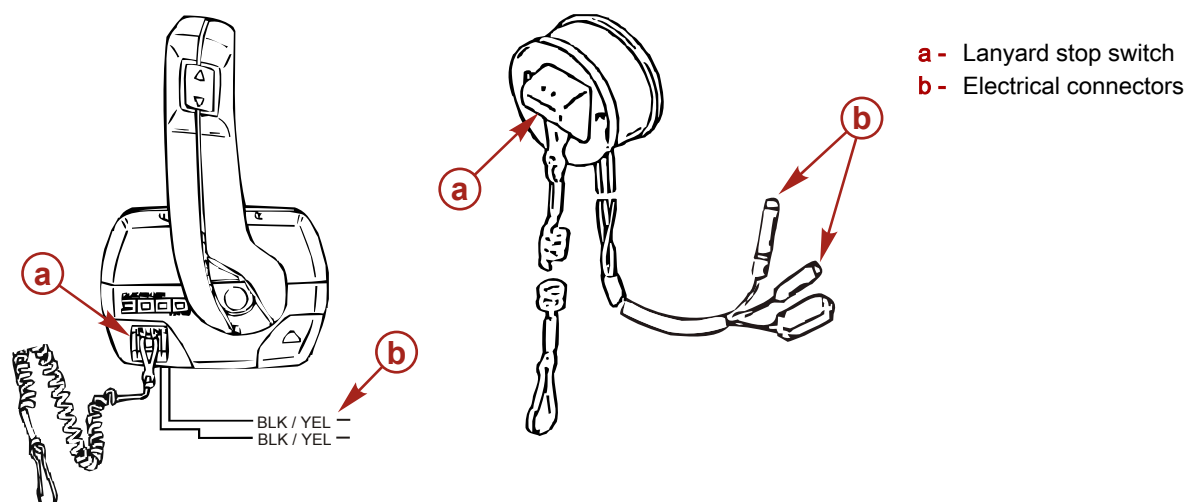
DMT 2004 Digital Multimeter	91-892647A01
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3. No continuity should exist during the initial test.
4. Press and hold down the switch. The circuit should have continuity.
5. A defective switch must be replaced.

Lanyard Stop Switch Testing

The lanyard stop switch is a normally open switch assembly that completes the ignition run circuit in the helm harness (black/yellow wire) when the lanyard key is properly inserted into the switch.

1. Disconnect the lanyard switch from the helm harness.
2. Connect the DMT test leads to the switch harness.



6496

3. The DMT should show continuity between the two harness wires when the switch key is in the run position. It should show no continuity with the switch key removed.
4. Replace the switch if continuity is not correct.

NOTE: When installing the lanyard stop switch, coat the electrical connectors with liquid neoprene to help resist corrosion.

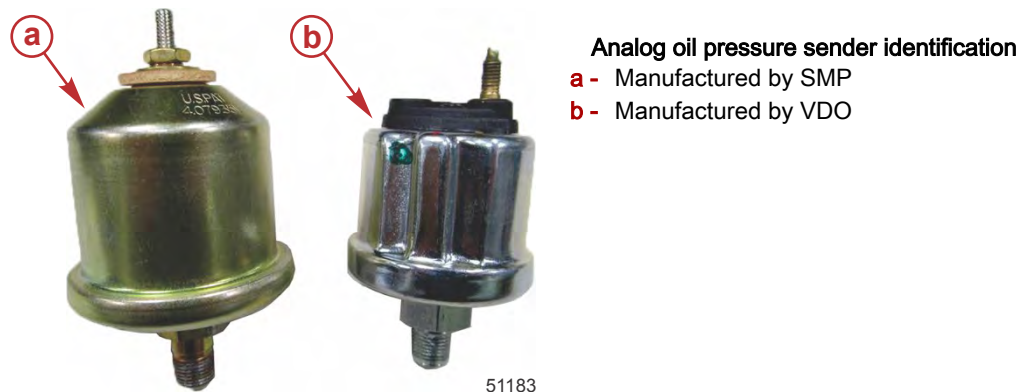
Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Electrical connections	92- 25711 3

Oil Pressure Sender

IMPORTANT: The following test procedure checks the accuracy of the oil pressure sender. Use a mechanical oil pressure gauge to verify engine oil pressure if low oil pressure is indicated.

NOTE: Dual-station applications use an oil pressure sender with a lower resistance range.

1. Use the images below to identify whether the sensor is manufactured by SMP or VDO.



51183

2. Remove the wire from the sender terminal.
3. Connect an ohmmeter between the sender terminal and the sender case.
 - a. With the engine off, measure the sender resistance with zero pressure.
 - b. With the engine running, measure and compare the sender resistance to the displayed oil pressure at the various readings in the appropriate chart.

SMP Oil Pressure Sender Specifications		
Oil Pressure	Resistance	
	Single Station	Dual Station
0	227–257 Ω	114–128 Ω
138 kPa (20 psi)	142–162 Ω	71–81 Ω

SMP Oil Pressure Sender Specifications		
Oil Pressure	Resistance	
	Single Station	Dual Station
276 kPa (40 psi)	92–113 Ω	46–56 Ω
414 kPa (60 psi)	9–49 Ω	5–24 Ω

VDO Oil Pressure Sender Specifications		
Oil Pressure	Resistance	
	Single Station	Dual Station
0	192–257 Ω	96–128 Ω
276 kPa (40 psi)	92–114 Ω	46–57 Ω
552 kPa (80 psi)	22–49 Ω	11–25 Ω

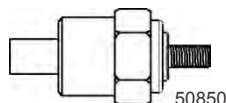
Water Temperature Sender Removal

NOTE: The water temperature sender is located in the thermostat housing.

1. Drain the coolant from the closed-cooling system into a suitable container.
2. Disconnect the tan wire from the temperature sender.
3. Remove the water temperature sender.

Water Temperature Sender Test

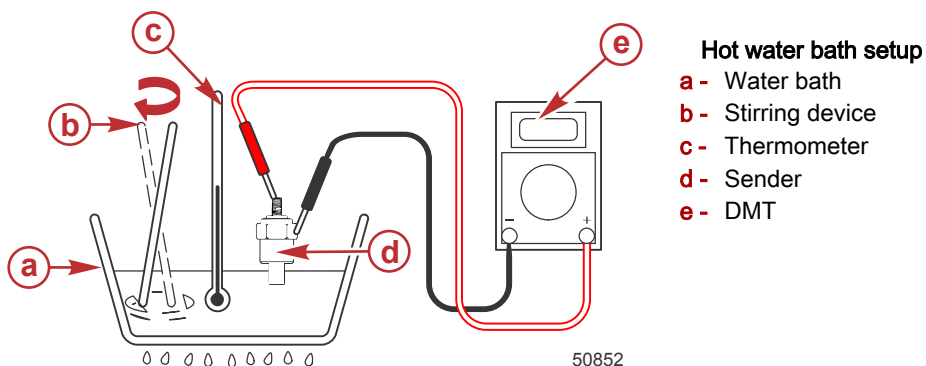
NOTE: This procedure tests the sender shown below, which is used for an analog temperature gauge.



1. Connect the positive (+) test lead of a digital multimeter and tester (DMT) to the sender terminal, and connect the negative (–) test lead to the sender hex flange.

DMT 2004 Digital Multimeter	91-892647A01
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2. Prepare a hot water bath using a suitable water container and a controlled heat source.
3. Place the water temperature sender into the hot water bath.
4. Place the thermometer into the hot water bath.
5. Measure the resistance when the specified temperature is reached. If it is out of specification, replace the sender.



Meter Test Leads		Meter Scale	Temperature	Reading* (Ω)
Red	Black			
Sender Terminal	Sender body	R x 1K	60° C (140° F)	121 to 147
			90° C (194° F)	47 to 55
			100° C (212° F)	36 to 41

Meter Test Leads		Meter Scale	Temperature	Reading* (Ω)
Red	Black			

* For dual-station applications, the resistance values will be approximately half of the listed values.

Water Temperature Sender Installation

1. Apply Loctite 567 to the threads of the temperature sender.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Sender threads	92-809822

2. Install the sender in the thermostat housing and tighten securely.
3. Connect the tan wire and coat the connection with liquid neoprene.

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Electrical connection	92- 25711 3

4. Refill the closed-cooling system with approved coolant.

Engine Coolant Temperature (ECT) Sensor

Low coolant temperature produces high resistance, while high temperature causes low resistance. The normal resistance value for the ECT sensor at 21° C (70° F) is 3.12 kΩ.

NOTE: All values listed in the following table are approximate.

Engine Coolant Temperature versus Sensor Resistance				
Temperature	Resistance		Temperature	Resistance
100° C (212° F)	185 Ω		4° C (39° F)	7500 Ω
70° C (158° F)	450 Ω		-7° C (19° F)	13,500 Ω
38° C (100° F)	1800 Ω		-18° C (0° F)	25,000 Ω
20° C (68° F)	3400 Ω		-40° C (-40° F)	100,700 Ω

A malfunction of the ECT sensor will set a fault of "Cool TEMP CKT Hi," "Cool TEMP CKT Lo," or "ECT Coolant Overheat."

Gear Lube Monitor Switch

The gear lube monitor switch is normally open when the fluid level is correct. If the gear lube is low the switch will close.

If the alarm sounds or gear lube level fault is set when the reservoir is filled to the correct level disconnect the wiring connector from the switch. If the alarm stops replace the switch.

Gasoline Engine Compression Test

Compression Gauge Testing

IMPORTANT: Use a fully charged battery during this testing procedure.

IMPORTANT: Compression test failures generally indicate a serious engine malfunction has occurred. The engine should be repaired prior to being returned to service.

IMPORTANT: Follow the instructions provided by the compression test gauge manufacturer. Use the correct threaded adaptor.

1. With the engine cold, verify that the battery is fully charged.
IMPORTANT: Ground the ignition coil to distributor cap wire directly to engine ground to prevent spark from the disconnected spark plug wires. A remote starting tool may energize the ignition coil through the "R" terminal of the starter solenoid even though the key and lanyard stop switches are in the OFF position.
2. Ground the ignition coil to distributor cap wire directly to engine ground or otherwise disable the ignition system.
3. Remove all of the spark plugs.
4. Temporarily stop the throttle lever in the WOT position to hold the throttle plate completely open.
5. Install the compression gauge to the cylinder being tested.
6. Zero the compression gauge.
7. Crank the engine, cycling the test cylinder through four compression strokes.
8. Record the compression test results for each cylinder.

Compression Test Diagnosis	
Minimum compression	690 kPa (100 PSI)
Compression difference (The lowest compression cylinder should be no less than 70% of the highest compression cylinder.)	70%

NOTE: Example: If the highest compression cylinder has 150 psi (1035 kPa) of compression, the lowest allowable pressure for any other cylinder would be 105 psi (725 kPa). [$150 \times 70\% = 105 \text{ psi}$ ($1035 \times 70\% = 725 \text{ kPa}$)].

- Repeat until all the cylinders have been tested.
- The interpretation of low cylinder compression test results can be aided by injecting three squirts of oil from a pump style oil can into the test cylinder combustion chamber and rechecking compression.

Possible Cause	Test Result	Further Testing
Normal	Compression builds quickly and evenly in each cylinder.	None
Leaking piston rings	Compression is low on the first stroke, increases on the following strokes but does not reach normal compression.	Inject three squirts of oil into the cylinder and retest. Compression should improve significantly.
Leaking valves	Compression is low throughout the test cycle.	Inject three squirts of oil into the cylinder and retest. No effect.
Leaking head gasket	Two adjacent cylinders have low compression.	Inject three squirts of oil into both cylinders and retest. No effect.

Leak Down Testing

Additional diagnosis of low compression cylinders can be performed using pressurized air to identify the source of combustion chamber leaks.

- Rotate the engine by hand until the number one cylinder is at top dead center (TDC) of the compression stroke.
- Identify and note the engine firing order.
- Rotate the crankshaft 60° to position the next cylinder in the firing order at TDC. Repeat until the first targeted test cylinder is positioned at TDC.

NOTE: Example with a firing order of 1-6-5-4-3-2: To test cylinder number 3, rotate the engine an additional 180° ($3 \times 60^\circ$) to position the fifth cylinder of the firing order, cylinder number 3, at TDC of its compression stroke. To continue the test and check cylinder number 2, rotate the engine an additional 60°.

- Thread the air supply adapter into the spark plug hole.
IMPORTANT: The air supply must be regulated to provide 138 to 206 kPa (20 to 30 psi) of air pressure. Use the appropriate, compression gauge style threaded adapter to introduce the pressurized air into the test cylinder.
- Hold the crankshaft balancer bolt with a large wrench to prevent the crankshaft from rotating when applying air pressure to the cylinder.
- Apply 138 to 206 kPa (20 to 30 psi) of air pressure through the adapter hose into the cylinder to be tested. Keep the crankshaft from rotating.
- Test result interpretation:

Possible Cause	Test Result
Leaking intake valve	Air is heard leaking up through the intake manifold at the throttle body or carburetor.
Leaking exhaust valve	Air is heard leaking into the exhaust system.
Leaking piston or piston rings	A high volume of air leaks into the test cylinder's rocker arm cover can be felt flowing out of the oil fill or breather cap (low volume air bleed past the rings is normal).

4.3L Turn Key Start (TKS) Systems

4.3L TKS Systems: Theory of Operation

- The 4.3L TKS carburetor provides additional fuel for cold starting and prevents excessive enrichment (flooding) when starting a warm engine.
- The TKS carburetor is equipped with a fuel enrichment circuit. Pumping the throttle twice before starting the engine is usually not necessary.

Troubleshooting

- The TKS enrichment fuel flow path is normally open (when starting a cold engine) and closes using a heat expanding device (captive wax pellet coupled to a brass plunger) as the engine warms up. The TKS module closes the fuel flow path after it is energized from a 12 volt DC circuit for 6–10 minutes.

TKS System Operation

The TKS carburetor assembly provides precise fuel and air delivery during starting in all temperature conditions. An electrothermal valve is installed on the carburetor assembly.



TKS module

The TKS fuel enrichment circuit is open when the engine is initially started, allowing fuel to pass through the carburetor until the passage is blocked by the plunger of the TKS module as the module warms.

When the key switch is in the start position additional fuel flows through the TKS fuel passage and enters the intake manifold. The brass plunger is extended to block the fuel passage as the TKS module gradually warms.



TKS module removed from carburetor

Enrichment stops when the TKS module brass plunger is fully extended.

TKS Starting Characteristics

TKS carbureted engines will typically start and run without advancing the throttle when the key switch is turned to the start position.

Engines that are being taken out of extended storage may require several cranking cycles to start the engine if fuel is no longer in the carburetor float bowl. The engine will idle between 650–700 RPM when it is initially started and may run faster due to the spark advance characteristics of the ignition control module (ICM). After the TKS module has closed the enrichment circuit, the carburetor will function like a standard carburetor. Engine idle RPM will stabilize below 700 RPM after several minutes of operation.

NOTE: When the ambient temperature is -17 – 55 °C (0 – 50 °F), normal engine idle should be 650–700 RPM in idle stabilization mode.

When the ambient temperature is 10 – 55 °C (50 – 130 °F), normal engine idle should be 700–900 RPM and exceed the idle stabilization mode, moving into the run spark mode. Once the enrichment circuit shuts off, the engine will idle at 650 RPM (idle stabilization mode).

TKS Troubleshooting

Normal Starting Procedure

1. Place the remote control handle in the neutral position.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

2. Turn the ignition key to the START position. Release the key when the engine starts and allow the key switch to return to the ON position.
3. Allow the engine to warm up (6–10 minutes on the first start of the day). The engine will initially idle at 650–900 RPM and then return to normal idle RPM for the engine.

Normal Engine Idle Specifications	Idle in Neutral	Idle in Gear
4.3L	650 RPM	650 RPM

4. If the engine does not start after three attempts:
 - a. Push the throttle only button and position the remote control throttle lever to the 1/4 throttle position.
 - b. Turn the ignition key to START. Release the key when the engine starts and allow the switch to return to the ON position.
5. If the engine does not start after step 4:
 - a. Move the remote control throttle lever to the full throttle position, then return to the 1/4 throttle position.
 - b. Turn the ignition key to START. Release the key when the engine starts and allow the switch to return to the ON position.
6. Inspect the power package for fuel, oil, water, and exhaust leaks.
7. To shift into gear, move the control handle with a firm, quick motion forward to shift to forward gear, or backward to shift to reverse. After shifting the drive unit, advance the throttle to the desired setting.

NOTICE

Shifting into gear at engine speeds above idle will damage the gearcase. Shifting into gear when the engine is not running can misalign the clutch, preventing proper shifting. Always shift the gearcase into gear when the engine is operating at idle. If you must shift while the engine is not operating, rotate the propeller shaft in the appropriate direction during shifting.

8. Move the remote control handle to neutral and the throttle lever to idle. Allow the engine to slow to idle speed. If the engine has been operated at high speed for a long period of time, allow the engine to cool at idle speed for 3–5 minutes.
9. Turn the ignition key to the OFF position.

Hard Start—Cold

1. If the engine does not start after the third attempt, verify the following:
 - a. There is sufficient fuel and the fuel shut off valve is open.
 - b. Ignition system is functioning.

Assuming that the carburetor is the cause of the hard starting condition, the probable cause will be that the additional fuel flow path is not functioning properly. To get the engine started:

1. Push the throttle only button.
2. Move the remote control throttle lever to the full throttle position and then to the idle position. Do this two times.
3. Place the throttle at 1/4 position (throttle only).
4. Attempt to start the engine again.
5. If the engine still does not start, refer to "Engine Does Not Start."

Hard Start—Hot

If the engine does not start when the engine is hot, the probable cause of hard hot-restarts associated with the TKS carburetor will be the inadvertent opening of the additional fuel flow path. The temperature switch was added to the system to keep power to the TKS module to prevent the additional fuel flow path from opening during hot restarts.

1. Check the coolant temperature.
2. If the coolant temperature is above $43\text{ }^{\circ}\text{C} \pm 3^{\circ}$ ($110\text{ }^{\circ}\text{F} \pm 8^{\circ}$):
 - a. Verify that 12 volts positive (+) and ground (–) are getting to the TKS module.
 - b. Operation of the TKS module can be confirmed by placing your finger on the end of the plastic TKS housing in the center and feeling that the electric heater is getting warm. A warm TKS module after the engine has run for 6–10 minutes confirms that TKS is functioning electrically.

Engine Does Not Start

The possible root causes of the fuel path not functioning include:

- The TKS module failed in the closed position.
- The fuel has varnished.
- There is debris in the fuel path.
- The float level is out of specification.

NOTE: Refer to **Disassembly and Repair in Section 5A** of this manual.

If the engine does not start, check the following:

1. Check that the float bowl is full of fuel.
2. Check that the mechanical fuel pump is working. Attach a fuel pressure gauge to the mechanical fuel pump to verify it is working correctly.
3. Check the enrichment jet emulsion tube, TKS enrichment jet, and the main jets for damage or debris.

Engine Does Not Idle Correctly

If the engine does not idle correctly after starting, verify that the enrichment cycle is fully closed before adjusting and check the following:

1. The engine idle RPM has been set correctly with a warm engine.
2. Verify the timing of the engine in the base timing mode.
3. Verify there is voltage on the Packard connector attached to the TKS heater.
4. Check the enrichment jet, emulsion tube, and the main jets for damage or debris.

Hissing Noise

There is a small enrichment air passage for the TKS system in the throat of the carburetor. Air is drawn through this passage when TKS is in starting mode and does create a slight whistle or hissing noise. After 6–10 minutes when the engine has warmed and the TKS system has closed, the noise will quit and will only occur again after a cold engine start. If this noise continues after 10 minutes, this could indicate a problem with the TKS module.

TKS Special Information

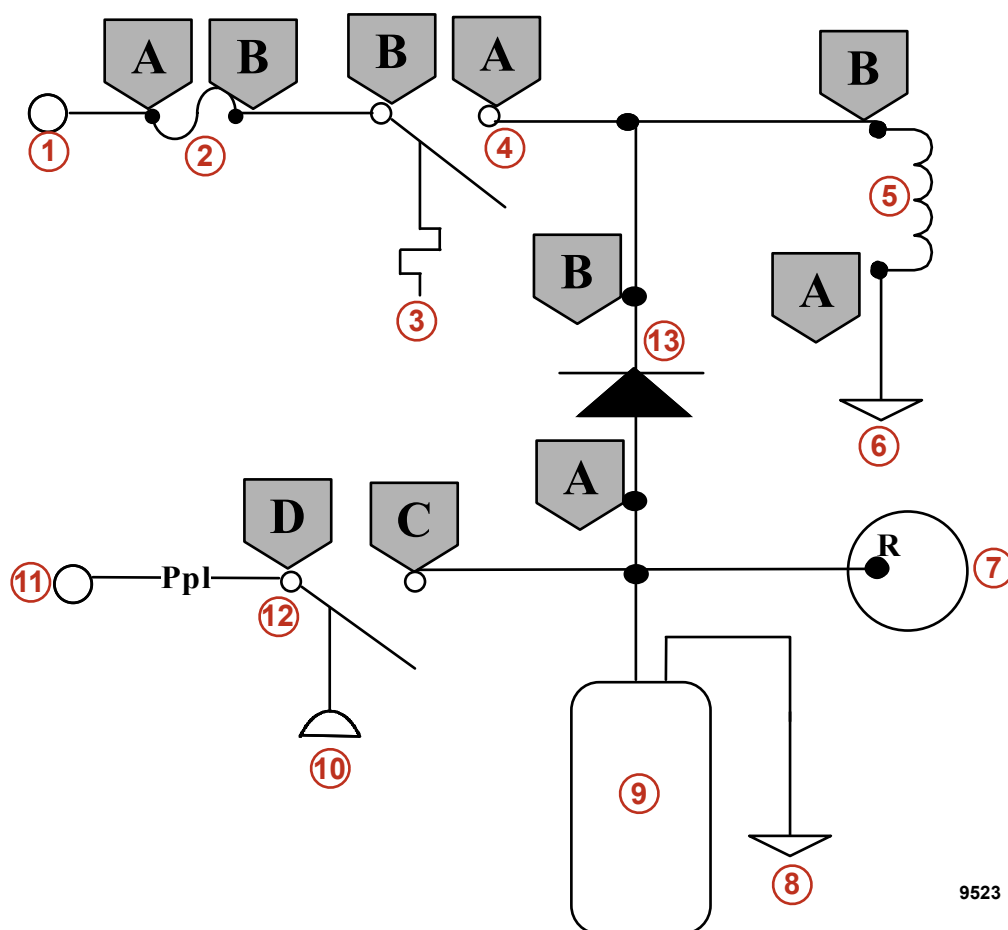
1. There will be a hissing sound for 6–10 minutes as the module is warming and the enrichment channel is being closed.
2. The base gasket on the TKS carburetor is different from the old base gaskets.
3. V6 engines use a spacer plate between the carburetor and manifold. The gaskets have the same part number. The plastic spacer has not been changed and still has the divider between the carburetor throats.
4. A special tool (P/N 91-866201) is available to allow for adjusting the idle mixture on TKS carburetors. The new adjustable idle mixture screw has a 16° taper and the special cap has been CARB approved to allow mixture adjustment only by dealers using the special tool. The new taper will provide a finer adjustment.

Idle Mixture Adjusting Tool	91-866201
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5. Do not make any adjustments of idle speed and/or idle mixture unless the engine is thoroughly warm and the TKS enrichment is completely shut off.
6. Generation 1 and Generation 2 carburetors function the same, and there is only a slight difference in the location of the TKS passage within the body.
7. Refer to the parts book for proper service components.

TKS Diagnostics

V6 TKS General Diagnostics



9523

- 1 - 12 volts
- 2 - Fuse (20 amp)
- 3 - Engine coolant
- 4 - Engine coolant temperature switch (normally open)
- 5 - TKS module (on carburetor)
- 6 - Ground
- 7 - Starter engagement solenoid
- 8 - Ground
- 9 - Fuel pump
- 10 - Oil pressure
- 11 - 12 volts, switched
- 12 - Engine oil pressure switch (normally open)
- 13 - Diode

NOTE: Switch contact state is either normally-open, or normally-closed. (Abbreviated "NO" or "NC.")

Component Characteristics

Component	Characteristic	Function
Engine oil pressure switch (normally open)	Open 0–4 psi. Closed above 4 psi.	Turns on TKS heater when oil pressure is above 4 psi.
Engine coolant temperature switch (normally open)	Open at room temperature. Closes at 130 °F opens at 110 °F.	Keeps the TKS module energized when the engine is warm.

Troubleshooting

Component	Characteristic	Function
Diode	Passes current in one direction	Allows the engine coolant temperature switch to energize the TKS module without energizing the fuel pump, ignition, gauges, etc.

General Diagnostics Tests

V6 Voltage Checks - With key switch OFF, and engine stopped, and engine cold			
Remove connector to	Test harness connector identification	Normal voltage	What to check if the voltage is not correct
20 A fuse	Fuse "A"	12	Battery connection, battery switch set to on
Temperature switch (normally open)	Temperature switch "B" (normally open)	12	Fuse
TKS module	TKS module "B"	0	Temperature switch

V6 Voltage Checks - With key switch ON, and engine stopped, and engine cold			
Remove connector to	Test harness connector identification	Normal voltage	What to check if the voltage is not correct
Oil pressure switch	Oil pressure switch "D"	12	Battery connection, battery switch is in the on position, key switch

V6 Voltage Checks - With key switch ON, and engine operating			
Remove connector to	Test harness connector identification	Normal voltage	What to check if the voltage is not correct
Diode	Diode "A"	12	Oil pressure switch
20 A fuse and TKS module	TKS module "B"	12	Diode

Fuel System Diagnostics

1. Test that power is reaching the fuel pump when the key switch is turned on.
2. If the pump is not getting power, use the appropriate wiring diagram found in the **MerCruiser Diagram Binder** to trace the power supply.
3. Inspect for chafed or broken wires or disconnected connectors. Repair or replace as necessary.
4. Test the TKS module plunger and ensure that it is extending as outlined in the **TKS Module Bench Test** procedure in this section.
5. Inspect and clean the enrichment circuit in the carburetor as outlined in **Section 5A** of this manual.
6. Pay particular attention to the enrichment jet and related fuel pathways, ensuring that they are clear and free of damage or residual buildup.

Replacement Parts Warning

WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

TKS Coolant Temperature Switch

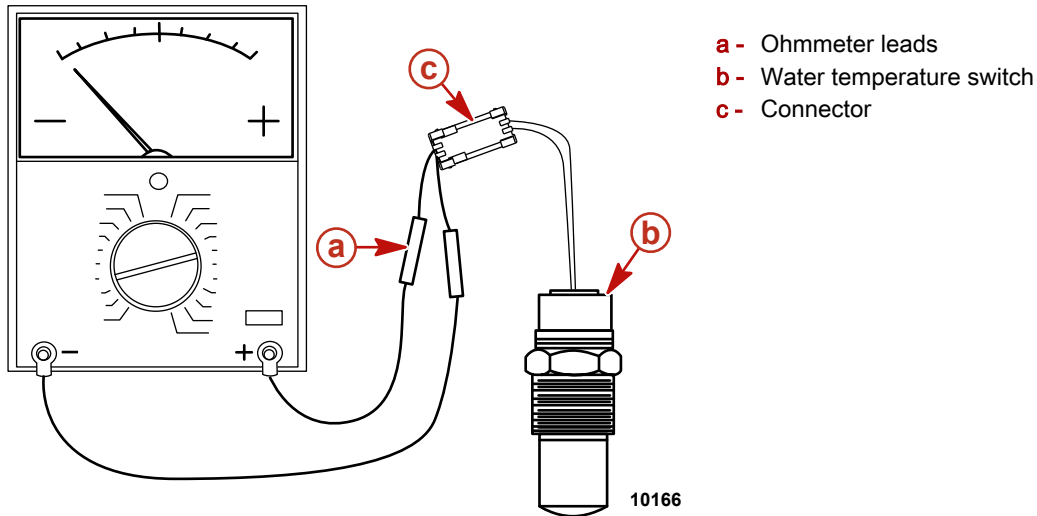
On-engine Test

1. Allow engine and switch to cool.
2. When engine and switch reach $43^{\circ}\text{C} \pm 4^{\circ}$ ($110^{\circ}\text{F} \pm 8^{\circ}$), check continuity.
3. If there is continuity, replace switch.
4. Start engine and allow engine to reach $55^{\circ}\text{C} \pm 4^{\circ}$ ($130^{\circ}\text{F} \pm 8^{\circ}$).
5. Disconnect coolant temperature switch connector and check for continuity again.

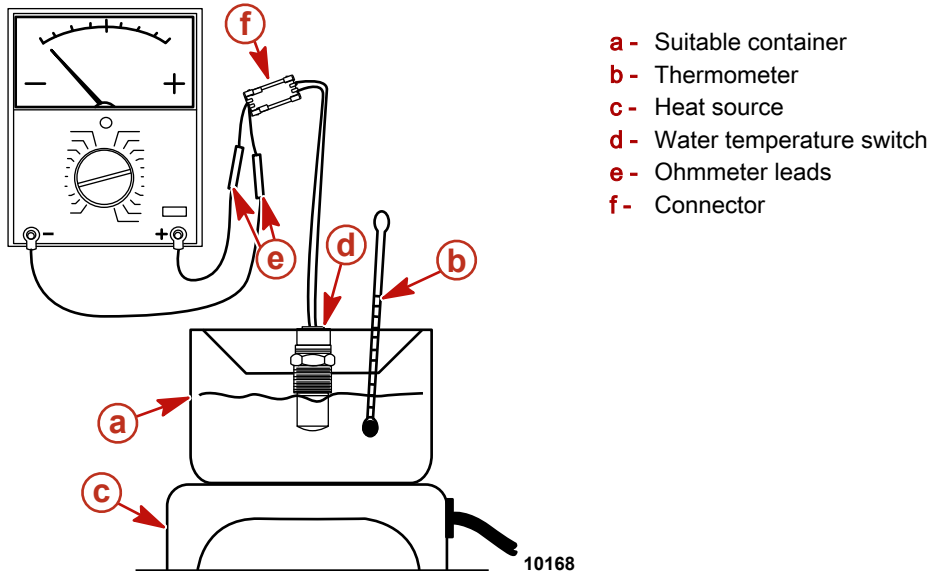
6. If there is no continuity, replace switch.

Bench Test

1. Connect an ohmmeter to the connector terminals of the coolant temperature switch.



2. Switch should read no continuity.
IMPORTANT: When conducting tests using a heat source, be sure to follow all instructions of the manufacturer of the heat source.
IMPORTANT: Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots, or other hazards.
3. Follow these instructions:
 - a. With an ohmmeter connected as shown and using a suitable container, thermometer and heat source, suspend sender with tip in sand.



- b. Heat the sand and observe the temperature on the thermometer.
 - c. As the temperature rises, the switch will close and the ohmmeter will indicate continuity. Refer to the following chart for the specifications.
- | Switch condition | Temperature |
|------------------|--------------------------|
| Closes | 54 °C ± 4° (130 °F ± 8°) |
| Opens | 43 °C ± 4° (110 °F ± 8°) |
4. Turn the heat source off and allow the sand to cool. Note thermometer reading to ensure switch opens at the specified temperature.

5. If switch fails to open or close within the specified temperatures, replace switch.

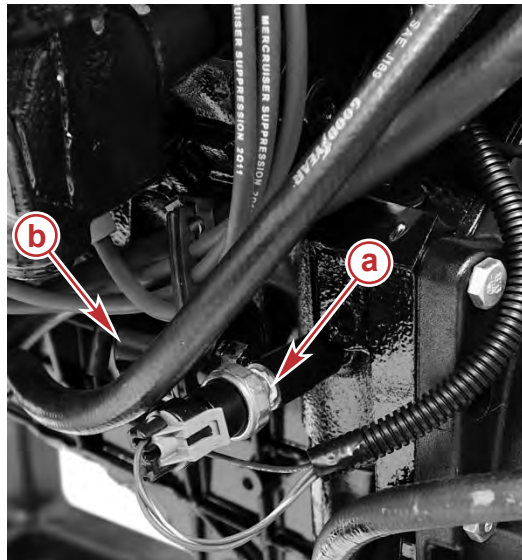
Oil Pressure Switch Test and Inspection

Inspect the TKS Oil Pressure Switch

1. Look for oil leaks around the base where the oil pressure switch connects to the engine.
2. Inspect for chafed or broken wires.
3. Inspect the housing for cracks or leaks.
4. Remove the switch and inspect for debris or a clog of the oil pressure inlet on the switch.
5. Correct the problem or replace the switch as needed.

Testing the Oil Pressure Switch

1. Disconnect the oil pressure switch connector from the harness.



- a** - Oil pressure switch
b - Oil pressure sender

53590

2. Connect the continuity meter to the oil pressure switch connector terminals. Ensure a good electrical connection is made.
3. With the engine not running, the meter should indicate no continuity.
4. With the engine running and engine oil pressure above 27 kPa (4 psi), the meter should indicate full continuity.
5. Replace the oil pressure switch if not functioning properly.

Oil Pressure Switch Replacement

1. Locate the oil pressure switch.
 - The oil pressure switch is located on the port side of the block, near the rear of the engine.
2. Disconnect the harness connector from the oil pressure switch.
3. Remove the oil pressure switch with a wrench on the hex part of the base.
4. Insert a new oil pressure switch and turn until hand-tight.
5. Tighten with a wrench on the hex part of the base to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil pressure switch	55	–	40

6. Connect the harness connector to the oil pressure switch.

TKS Module

Perform the following checks in the order listed to identify a faulty module.

Electrical Supply

1. Check the in-line fuse to the TKS module. Replace if faulty.
2. Use the appropriate wiring diagram found in the **MerCruiser Diagram Binder** to determine the wire colors for your particular application.

3. With a digital voltage ohmmeter (DVOM), check the voltage in the wires going to and from the TKS module connector on the wiring harness.
4. With the key switch on and engine running (oil pressure greater than 27 kPa [4 psi]), the positive wire (either red/purple or white) should indicate 12 volts.
5. With the key switch on and engine running (oil pressure greater than 27 kPa ([4 psi]), the negative wire (either black/yellow or black) should have continuity to ground (-).
6. If these conditions do not exist, correct electrical supply problem and retest.

Heater Function

1. If the TKS unit is getting power, turn on engine for 8–10 minutes.
2. Feel the back of the TKS module (where the wires enter the unit) with a finger.
3. The TKS unit should feel warm to the touch.
4. If the TKS module is not warm, replace the TKS module as described in **Section 5A**.

TKS Module Resistance Check

1. Disconnect the wire harness from the TKS.
2. Measure the TKS module resistance.
3. Replace if out of specification.

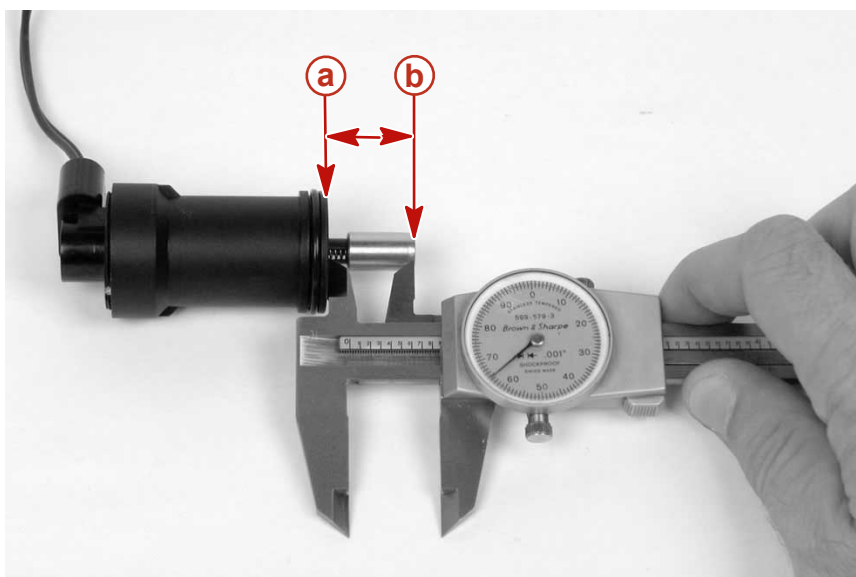
TKS Module Resistance		
Ambient temperature	21 °C (70 °F)	35–45 ohms
	-6.6 °C (20 °F)	55–70 ohms

TKS Module Bench Test

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. Close the fuel shut off valve.
2. Remove the TKS module from the carburetor as outlined in **Section 5A**, and detach the connector.
3. Inspect the brass plug and the rubber disc at the end of the plunger. Replace the TKS unit if worn or damaged.
4. Attach the TKS connector terminals to a 12 volt power supply.
5. With the TKS module at room temperature, the plunger should extend 20.6–22.2 mm (0.812–0.875 in.) from the face of the TKS module.



- a** - Face
- b** - End of plunger

10133

6. As the TKS module warms up, the plunger should start to extend.

7. After 8–10 minutes, the plunger should extend approximately 31.75 mm (1.25 in.) from the face of the TKS module.
8. If the plunger does not extend, or extend fully, replace the TKS module as described in **Section 5A**.
9. Install the TKS Module as outlined in **Section 5A**.

4.3L MPI Systems

Precautions

WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Service Precautions

Observe the following:

IMPORTANT: Before removing any ECM system component, disconnect both battery cables.

CAUTION

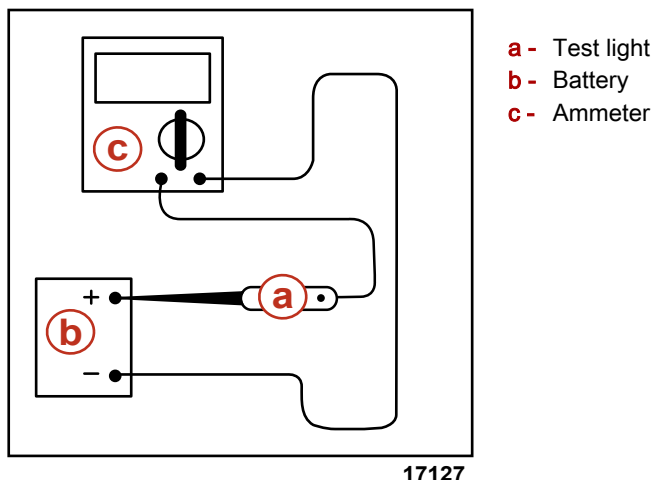
Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

- Never start the engine without the battery being solidly connected.
- Never separate the battery from the onboard electrical system while the engine is operating.
- Never disconnect battery cables from the charging system while the engine is operating.
- When charging the battery, disconnect it from the boat's electrical system.
- Ensure that all cable harnesses are connected and that battery connections are clean.
- Never connect or disconnect the wiring harness at the ECM when the switch is in the on position.
- Before attempting any electric arc welding, disconnect the battery leads and the ECM connectors.
- When steam cleaning engines, do not direct the steam cleaning nozzle at ECM system components. Steam can cause corrosion of the terminals or damage of components.
- Use only the test equipment specified in the diagnostic charts; other test equipment may either give incorrect results or damage good components.
- All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 Meg Ω input impedance.
- When using a DMT to perform voltage measurements, switch to the off position when connecting the DMT to the circuitry being tested.

- When a test light is specified, a low-power test light must be used. Do not use a high-wattage test light.

While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing.

Connect an accurate ammeter (such as the DMT) in series with the test light being tested and power the test light ammeter circuit with the battery.



IMPORTANT: If the ammeter indicates less than 0.3 amp current flow (0.3 A or 300 mA), the test light is safe to use. If the ammeter indicates more than 0.3 amp current flow (0.3 A or 300 mA), the test light is not safe to use.

NOTE: Using a test light with 100 mA or less rating may show a faint glow when the test actually states no light.

General Information

Electrostatic Discharge Damage

Electronic components are often designed to carry very low voltage and are susceptible to damage caused by electrostatic discharge. Even less than 100 volts of static electricity can cause damage to some electronic components. By comparison, it takes 4,000 volts for a person to even feel the effect of a static discharge.

A person can become statically charged in many ways. The most common methods are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily grounds the circuit. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage to electronic components. Use care when handling and testing electronic components.

Wiring Harness Service

Service marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used.

IMPORTANT: Before component replacement and during normal troubleshooting procedures, visually inspect any questionable mating connector.

The proper operation of low amperage input and output circuits depends upon good continuity between circuit connectors. Mating surfaces should be properly formed, clean, and likely to make proper contact. Some typical causes of connector problems are listed below.

1. Improperly formed contacts or connector housing.
 - Damaged contacts or housing due to improper connection.
 - Corrosion, sealer, or other contaminants on the contact mating surfaces.
2. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
3. Tendency for connectors to come apart due to vibration and temperature cycling.
4. Terminals not fully seated in the connector body.
5. Inadequate terminal crimps to the wire.

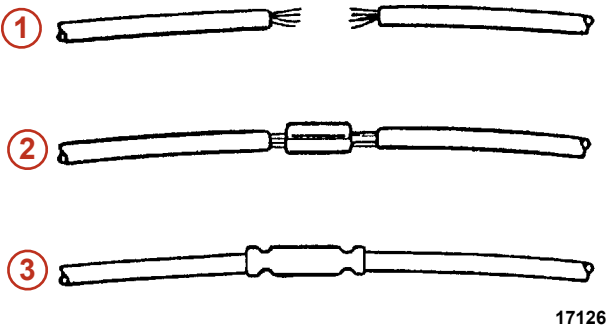
Wire harnesses should be replaced with the appropriate replacement part. For the correct harness, refer to the specified part numbers. When signal wires are spliced into a harness, only use specified wire the same gauge as the existing harness in accordance with ABYC E11.

With the low current and voltage levels found in the system, carefully solder splices and create the best possible connection. Refer to **Wire Repair**.

Use care when probing a connector or replacing connector terminals. Avoid possible shorts between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. NEVER probe through connector seals, wire insulation, secondary ignition wires, boots, or covers. Microscopic damage or holes will result in eventual water intrusion, corrosion, or component or circuit failure.

Wire Repair

Locate the damaged wire and repair as shown:



- 1. Remove insulation as required.
- 2. Splice two wires together using splice clips and rosin core solder.
- 3. Cover the splice with a heat-shrink sleeve to insulate.

Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt that could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock that secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

Open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the **Mercury Precision Parts and Quicksilver Accessories Guide**.

Ensure that the connector seals are not deformed or crushed when mating the connectors together.

Intermittent Problems

IMPORTANT: Intermittent problems may or may not store a fault. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform a careful visual check for the following conditions:

- Poor mating of the connector halves or a terminal not fully seated in the connector body.
- Intermittent problems may or may not store a fault. The fault must be present to locate the problem.

All connector terminals in the problem circuit should be carefully checked for proper contact tension.

- Poor terminal-to-wire connection (crimping). Remove the terminal from the connector body to check.

The vessel may be driven with a digital multimeter connected to a suspected circuit. An abnormal voltage when malfunction occurs is a good indication that there is a fault in the circuit being monitored.

A diagnostic tool, such as CDS, can be used to help detect intermittent conditions. The CDS allows manipulation of wiring harnesses or components with the engine not operating, while observing the scan tool readout. The CDS can also be connected and observed while operating the vessel.

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
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If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while operating the vessel. If there does not seem to be any correlation between the problem and a specific circuit, use the diagnostic tool data to see if there is any change in the readings that might indicate intermittent operation.

The CDS is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a fault. Comparing the sensor readings with those of the typical scan tool data readings may uncover the problem.

Using the CDS tool can save time in diagnosis and prevent the replacement of good parts. To use the tool successfully, the technician must understand the system being diagnosed and the CDS operation and limitations. The technician should read the CDS tool operating manual provided by the manufacturer to become familiar with operation of the tool. Also, an electronic help program is included with the CDS tool.

To check loss of fault memory, disconnect the TP sensor and idle the engine. Attach the CDS tool. The fault TPS1 CKT Lo should be stored and kept in memory when the ignition is turned "OFF." If not, the ECM/PCM is faulty. When this test is completed, clear the fault.

An intermittent problem may be caused by the following:

- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- Poor ECM/PCM grounds.
- An electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- Improper installation of electrical options such as lights, ship-to-shore radios, and sonar.

4.3L MPI Systems: Theory of Operation

General Description

The Mercury MerCruiser electronic fuel injection system is equipped with a computer that provides the engine with state-of-the-art control of fuel and spark delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure, but voltage does not flow in circuits. Instead, voltage causes current flow. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays, and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

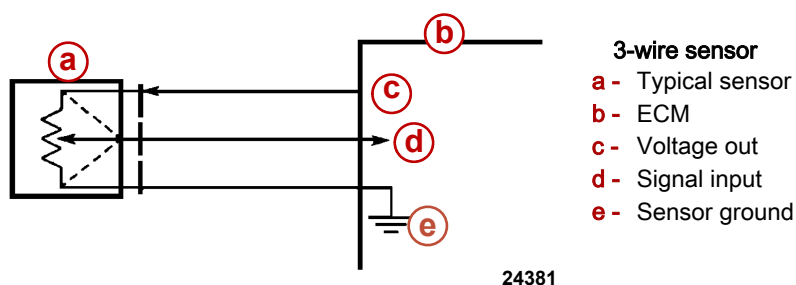
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

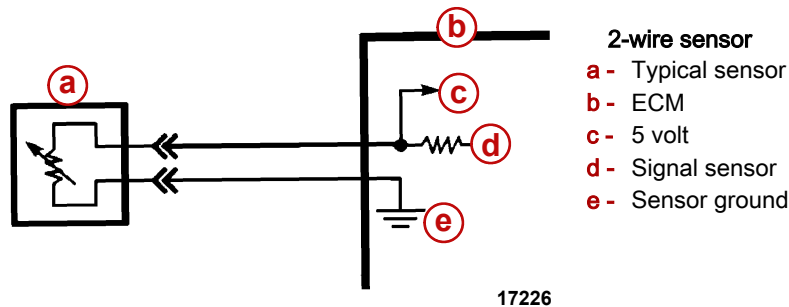
Three-Wire Sensors

The following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground, and a variable wiper. The lead coming off of the wiper will be the signal to the engine control module (ECM). As this wiper position changes, the signal voltage returned to the computer also changes.



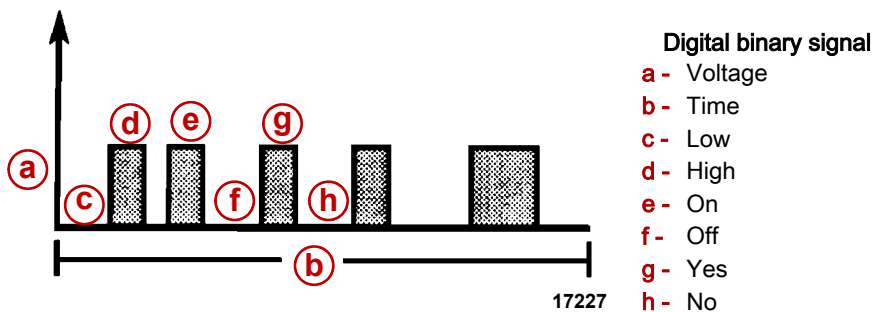
Two-Wire Sensor

The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.



Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1 V, 2 V, or 3 V are distinct voltages, but 1.27 V or 2.65 V, the values between those distinct voltages are not. Digital signals are especially useful when the information refers to the following conditions: yes and no, on and off, or high and low. This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in the following figure, a digital binary signal is a square wave.



The computer uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a bit. Eight bits together are called a word. A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should reset engine RPM at a lower level. Although the computer uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

Switch Types

Switched inputs (also known as discretes) to the computer can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types: they are pull-up and pull-down types. Both types will be discussed.

With a pull-up type switch, the ECM will sense a voltage when the switch is closed. With the pull-down switch, the ECM recognizes the voltage when the switch is open.

Discretes can also be used to inform a computer of frequency information.

Pulse Counters

For the computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution, and determine the RPM of the engine.

Engine Control Module (ECM)

The engine control module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.

ECM Function

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a 10-megaohm input impedance digital voltmeter is required to ensure accurate voltage readings.

Engine Guardian System

General Description

Engine Guardian is the focal point of the self-diagnostic strategy on these engines. It helps protect the engine from possible damage that could result from several faulty conditions. The system monitors the sensors incorporated on the engine and, if a malfunction is discovered, the system stores a fault description in the ECM/PCM and available power may be reduced. By ensuring that engine output is at a low enough level, the engine is better protected from mechanical failures.

For example, if an open or short is found in any sensor, available power is reduced to 90% of total, the audio warning system alarm will sound 2 beeps per minute (2 Bp/min) and the SmartCraft gauges will display a warning lamp. In a seawater pump pressure low condition, the maximum RPM will vary with the pressure and temperature of the engine and could be limited to idle in extreme cases of overheating, a constant beep will sound and SmartCraft gauges will display a warning lamp.

IMPORTANT: Engine Guardian cannot guarantee that engine damage will not occur when adverse operating conditions are encountered. Engine Guardian is designed to warn the operator of an adverse condition and to reduce power by limiting RPM in an attempt to reduce possible engine damage. The boat operator is ultimately responsible for proper engine operation.

CDS and ECM 555 Diagnostics

CDS PC Minimum Specifications

NOTE: Minimum specifications are established to support both CDS and CDS G3. PC minimum specifications:

- Windows XP Professional or Windows 7 Professional
- 1.2 GHz Pentium processor
- 2 GB RAM
- 120 GB hard drive
- 10/100 ethernet
- 802.11 b/g/n wireless
- DVD ROM optical drive
- USB 2.0 port (qty. 3) to accommodate CDS USB components
- Optional 9-pin serial port

NOTE: Refer to **Mercury Service Bulletin 2012-01** for specific software, USB to serial adapter, and CDS diagnostic tool information.

Computer Diagnostic System (CDS)	Available through Bosch Automotive Service Solutions
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Refer to **Mercury MerCruiser Service Manual #36** for comprehensive ECM 555 diagnostic information and fuel pressure testing. Refer to the **Mercury MerCruiser Diagrams Binder** for detailed diagrams and wiring schematics.

CDS Connection to the Engine

For complete information about selecting the appropriate engine interface cables, connecting CDS to the engine, and system program operation, refer to the CDS software help system provided with the CDS program. CDS help is a quick-access reference tool that provides comprehensive information on all of the various topics related to the Mercury Marine computer diagnostic system including proper CDS connection to the engine.

CDS Power Up

1. Ensure that the ignition key switch is in the "RUN" position.

NOTE: If a red Mercury SmartComms icon is flashing in the lower left corner of the screen, the CDS software cannot communicate with the SmartComm interface box. If a yellow Mercury SmartComms icon is flashing in the lower left corner of the screen, the SmartComms interface box is detected, but the CDS software cannot communicate with the ECM/PCM. Check the connections, ensure that the ignition key is turned on, and verify that the correct engine has been selected (identified in the title bar at the top of the screen).

2. Click the Engine Select button to enter engine information. Choose the make, model, and serial number range.

3. Enter an engine serial number. When a valid engine serial number is entered, a green check mark will appear.
4. Click the green check mark to accept the engine information.

MerCruiser ECM Fault Information and Troubleshooting

MerCruiser ECM/PCM Fault Diagnostic Tools

Use the diagnostic tools to collect fault messages, and use the following chart to interpret the faults and their possible causes.

12-volt connector tool, PCM/ECM Wake-up	91-889675A01
2- to 4-pin harness adapter	84-822560A12
Adapter harness	84-822560A13
Male-to-male 10-pin adapter	84-892452A01
CAN 1 diagnostic cable	84-892663
Computer diagnostic system (CDS)	Available through Bosch Automotive Service Solutions
Breakout box	P/N MM-46225 (Available through Bosch Automotive Service Solutions)
Terminal test probe kit	P/N MM-46523 (Available through Bosch Automotive Service Solutions)

ECM/PCM Fault List Information

NOTE: All of the following are determined by the calibration of the ECM/PCM. Upgrading the calibration can result in changes to these settings.

Fault Conditions

Most faults can be detected with the engine running, or with the key on and engine off. However, some faults require the presence of engine RPM, and cannot be detected with the key on but the engine off. Examples of this type of fault are EST (cylinders 1 through 8) shorted circuit and all injector faults (fuel and direct).

Some faults are only detected with the key on and engine off. Examples of the type of fault are EST (cylinders 1 through 8) open circuit.

In addition, some faults are programmed to ignore certain engine speeds. For example, the low block pressure sensor fault (sea pump pressure on a MerCruiser sterndrive) is typically not enabled until enough load has been achieved to develop a reasonable amount of water pressure. Therefore, this fault will not be set at idle.

Faults also take a certain time to set. The time it takes to set a fault varies greatly and can also vary with engine RPM. Faults generally set faster at higher engine speed.

Sticky and Non-Sticky Faults

All faults are classified as either sticky or non-sticky. Sticky means that the fault, once set, will continue to show up as active, even if the circuit or problem has corrected itself. A key switch cycle is required to reset a sticky fault.

A non-sticky fault is a fault that will change its status from active to inactive without requiring a key switch cycle.

The CDS diagnostic tool will continue to display a sticky fault as active even though the cause of the fault has been corrected. Cycle the key to reset all faults if there is difficulty correcting a fault.

Default Sensor Values

Default sensor values are preprogrammed amounts used by the PCM to calculate fuel and ignition values, when the sensor in question has exceeded its preprogrammed diagnostic limits. Default sensor values typically are used when the sensor has a circuit high or circuit low fault.

Most temperature sensors default to 0 °C (32 °F). This can be verified by unplugging the sensor in question and watching the data stream value with the CDS.

Most pressure sensors default to a preprogrammed number also. MAP sensors usually default to 70 kPa (20.7 in. Hg). This can be verified by unplugging the sensor in question and watching the data stream value. Other pressure sensors will have their own default values which may be determined as described previously.

CDS and SmartCraft Troubleshooting

MerCruiser ECM/PCM Fault List

NOTE: All of the following are determined by the calibration of the PCM. Not all faults are used on each engine. This information is accurate as of the date of printing. Fault information is subject to change at any time.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
1	Battery Voltage High	Critical - High Voltage	Battery voltage is above normal limit. Refer to Owner's Manual for more information.	Return to port immediately - Service engine before next use.	Battery voltage above allowable threshold. The further the threshold is exceeded, the more Guardian reduces power.	Alternator. Alternator sense wire. Short to +24VDC trolling motor harness.
2	Battery Voltage Low	Critical - Low Voltage	Battery voltage is below normal limit. Turn off unnecessary loads, increase engine RPM and check battery conditions.	Return to port immediately - Service engine before next use.	Battery voltage below allowable threshold. The further the threshold is exceeded, the more Guardian reduces power.	Alternator. Belt slipping. Defective battery (shorted cells). Too much electrical load.
3	Block Water Pressure is Low	Water Pressure	Water pressure in the cooling system is low. Water pump may be faulty.	Non-critical - Service engine soon.	Water pressure in the engine block low. Guardian is active. Variable power limit depends on block pressure, port and starboard coolant temperature, and RPM.	Blockage at gearcase inlets. Failed water pump. Failed water tube. Leak between block and sensor. Sensor bad but not open or short.
5	ETC Loss of Control	Critical - Throttle Control	Throttle position control is not working properly.	Return to port immediately - Service engine before next use.	Feedback from the ETC indicates actual throttle blade position does not match ERC position.	Faulty ETC. Check TPS voltage readings with DDT or CDS. Check connection to the ETC. Faulty ERC.
6	ETC Sticking	Critical - Throttle Control	Throttle position control is not working properly.	Return to port immediately - Service engine before next use.	Throttle blade is not responding to the ETC. The blade is stuck or obstructed.	ETC failed. Corrosion between terminal pins on ETC connection. Obstruction in throttle bore. Low battery voltage. Wiring problem.
9	Guardian Strategy	Engine Power Limited	Engine Guardian is active. Power will be limited to prevent engine damage.	Reduce engine RPM.	Guardian is trying to protect the engine by reducing power.	Check for other faults. The Guardian is a result of other faults. Failed sensor.
10	Knock Sensor 1	Knock Sensor	Engine knock sensor is not working properly. Knock prevention system is not functioning. Avoid running engine at maximum power.	Non-critical - Service engine soon.	The knock sensor is expected to sense a minimum amount of vibration. Too little of a signal will cause this fault. Too much and the knock control becomes active.	Failed sensor. Bad wiring. Poor mounting.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
11	Knock Sensor 2	Knock Sensor	Engine knock sensor is not working properly. Knock prevention system is not functioning. Avoid running engine at maximum power.	Non-critical - Service engine soon.	The knock sensor is expected to sense a minimum amount of vibration. Too little of a signal will cause this fault. Too much and the knock control becomes active.	Failed sensor. Bad wiring. Poor mounting.
12	Oil Pressure is Low	Oil Pressure	Engine oil pressure is low. Stop engine and check oil level.	Service engine soon - Refer to Owner's manual for service procedure.	Oil pressure low. Guardian is active. Variable power limit depends on RPM.	Low oil level. Blockage in oil system. Sensor is bad but not open or short. Sensor is open or short.
15	MAP Sensor Circuit High	Engine Sensor	Manifold absolute pressure sensor is not working properly. This fault will result in reduction of engine performance.	Non-critical - Service engine soon.	MAP circuit shorted. Airflow calculation is no longer valid. Power limit is active. Fueling level is a straight lookup based on demand of TPI and RPM.	Wiring problem. Sensor problem.
16	MAP Sensor Circuit Low	Engine Sensor	Manifold absolute pressure sensor is not working properly. This fault will result in reduction of engine performance.	Non-critical - Service engine soon.	MAP circuit open. Airflow calculation is no longer valid. Power limit is active. Fueling level is a straight lookup based on demand of TPI and RPM.	Wiring problem. Sensor problem.
17	MAP Sensor Idle Fault	Engine Idle	Engine is receiving too much air in the idle state, possible manifold leak.	Non-critical - Service engine soon.	The engine is expected to pull a little vacuum on the inlet at idle. If there is no difference in PSI drop from key-on to running, the MAP sensor may be bad or airflow disrupted in the intake system.	MAP sensor failed. Throttle bore missing or oversized. Wiring problem. Air flow disrupted in intake.
19	Maximum RPM Exceeded	Engine Overspeed	Excessive engine speed. Possible causes: Trim angle or improper propeller.	If condition persists - Service engine soon.	Recommended RPM range exceeded. First, horn sounds. Second, cylinders stop firing. Third, more cylinders stop firing.	Prop too small. Too much trim. Too high on transom. Too much vent in prop. Too much throttle in neutral. Gearcase problem.
21	ECT Overheat	Overtemp	Engine is overheating. Check for plugged water inlet. Water pump may be faulty.	Non-critical - Service engine soon - Refer to Owner's manual for service procedure.	1. Water temperature in head high. Guardian is active. Variable power limit depends on block pressure, port and starboard coolant temperature, and RPM. 2. Engine coolant sensor exceeds a specified threshold.	Blockage at gearcase inlets. Failed water pump. Failed water tube. Blockage in head or thermostat dump. Sensor out of specification.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
22	Warning Horn Output	Warning Horn	Warning horn in boat is not operating. There will be no audible alarm in case of engine malfunction.	Non-critical - Service engine soon.	Warning horn in boat not operating. No audible alarm will be heard in event of engine malfunction.	Horn failed or missing. Horn not connected. Horn circuit open. Horn driver in ECM failed.
36	Sea Pump Pressure Circuit High	Engine Sensor	Water pressure sensor is not working properly.	Non-critical - Service engine soon.	Block pressure sensor circuit shorted.	Wiring problem. Sensor problem.
37	Sea Pump Pressure Circuit Low	Engine Sensor	Water pressure sensor is not working properly.	Non-critical - Service engine soon.	Block pressure sensor circuit is open.	Wiring problem. Sensor problem.
39	Manifold Air Temp Circuit High	Temperature Sensor	Engine air temperature sensor is not working properly.	Non-critical - Service engine soon.	Air temperature sensor circuit open. Power is limited.	Wiring problem. Sensor problem.
40	Manifold Air Temp Circuit Low	Temperature Sensor	Engine air temperature sensor is not working properly.	Non-critical - Service engine soon.	Air temperature sensor circuit shorted. Power is limited.	Wiring problem. Sensor problem.
43	EST 1 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
44	EST 1 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.
45	EST 2 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
46	EST 2 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.
47	EST 3 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
48	EST 3 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
49	EST 4 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
50	EST 4 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.
51	EST 5 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
52	EST 5 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.
53	EST 6 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
54	EST 6 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.
55	EST 7 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
56	EST 7 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.
57	EST 8 Open Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module open. Detectable only at zero RPM.	Wiring problem. Coil problem.
58	EST 8 Shorted Circuit	Ignition	Ignition coil is not working properly.	Non-critical - Service engine soon.	Ignition fault. Signal from ECM to ignition driver module shorted. Detectable only at RPM.	Wiring problem. Coil problem. May see this fault during overspeed as ignition trigger signal is being turned off.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
59	Fuel Injector 1 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
60	Fuel Injector 1 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
61	Fuel Injector 2 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
62	Fuel Injector 2 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
63	Fuel Injector 3 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
64	Fuel Injector 3 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
65	Fuel Injector 4 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
66	Fuel Injector 4 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
67	Fuel Injector 5 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
68	Fuel Injector 5 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
69	Fuel Injector 6 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
70	Fuel Injector 6 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
71	Fuel Injector 7 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
72	Fuel Injector 7 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
73	Fuel Injector 8 Open Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Insufficient current draw on fuel injector circuit.	Open connection to injector on harness. Bad fuel injector.
74	Fuel Injector 8 Shorted Circuit	Fuel Injector	Fuel injector is not working properly.	Non-critical - Service engine soon.	Current draw of fuel injector has exceeded its limit.	Shorted connection to injector on harness. Bad fuel injector.
75	Fuel Level 1 Circuit High	Fuel Sender	Fuel level sensor is not working properly.	Non-critical - Service engine soon.	Fuel level sensor circuit open. This is primary fuel tank if two tanks are used.	Wiring problem. Sensor problem. If sensor is not installed this is a normal fault message.
76	Fuel Level 1 Circuit Low	Fuel Sender	Fuel level sensor is not working properly.	Non-critical - Service engine soon.	Fuel level sensor circuit shorted. This is primary fuel tank if two tanks are used.	Wiring problem. Sensor problem.
77	Camshaft Sensor Fault	Engine Sensor	Engine crank/cam encoder is not working properly.	Non-critical - Service engine soon.	Cam position sensor circuit is faulty. Fuel and ignition strategies will be modified.	Wiring problem. Sensor problem.
80	Main Power Relay Output	Critical - Engine Voltage	Main power relay is not working properly.	Return to port immediately - Service engine before next use.	Key switch +12v and driver power do not agree within calibrated limits.	Low battery voltage. Poor battery connections or cables. Relay problem.
81	Main Power Relay Backfeed	Engine Voltage	Main Power Relay Backfeed	Non-critical - Service engine soon.	Unintended voltage being supplied back to ECU. Fault declared if voltage regulator in ECU is off, but ECU senses voltage on driver power.	Wiring problem. Relay problem.
84	Oil Pressure Circuit High	Engine Sensor	Engine oil pressure sensor is not working properly.	Non-critical - Service engine soon.	Oil pressure sensor circuit shorted.	Wiring problem. Sensor problem.
85	Oil Pressure Circuit Low	Engine Sensor	Engine oil pressure sensor is not working properly.	Non-critical - Service engine soon.	Oil pressure sensor circuit open.	Wiring problem. Sensor problem.
89	Oil Temperature Circuit High	Temperature Sensor	Engine oil temperature sensor is not working properly.	Non-critical - Service engine soon.	Oil temperature sensor circuit is open.	Wiring problem. Sensor problem.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
92	Paddle Wheel Sensor Fault	Sensor	Paddle wheel is not working properly.	Non-critical - Service engine soon.	Paddle wheel is not operating properly.	Wiring problem. Sensor problem.
93	Pitot Pressure Circuit High	Sensor	Pitot sensor is not working properly.	Non-critical - Service engine soon.	Pitot pressure sensor (used for boat speed) circuit shorted.	Wiring problem. Sensor problem.
94	Pitot Pressure Circuit Low	Sensor	Non-Critical - Service Engine Soon.	Non-critical - Service engine soon.	Pitot pressure sensor (used for boat speed) circuit open.	Wiring problem. Sensor problem.
97	Port Tab Circuit High	Sensor	Trim tab sensor is not working properly.	Non-critical - Service engine soon.	Port tab sensor circuit open.	Wiring problem. Sensor problem.
98	Port Tab Circuit Low	Sensor	Trim tab sensor is not working properly.	Non-critical - Service engine soon.	Port tab sensor circuit shorted.	Wiring problem. Sensor problem.
99	Port Tab Down Solenoid Output	Trim Tab	Tab down controller is not working properly.	Non-critical - Service engine soon.	Problem with trim tab solenoid.	Wiring problem. Sensor problem.
100	Port Tab Up Solenoid Output	Trim Tab	Tab down controller is not working properly.	Non-critical - Service engine soon.	Problem with trim tab solenoid.	Wiring problem. Sensor problem.
101	CAN Comm. Fault Type 1	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Wiring problem on the CAN X (2) primary control data system.
102	CAN Comm. Fault Type 2	Communication Error	There is a communication problem with the SmartCraft control system.	Non-critical - Service engine soon.	CAN bus	Wiring problem on the CAN V (3) system.
103	CAN Comm. Fault Type 3	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Wiring problem on the CAN P (1) redundant control data system.
104	Lake/Sea Temp Circuit High	Temperature Sensor	Sea water temperature sensor is not working properly.	Non-critical - Service engine soon.	Boat-mounted water temperature sensor circuit open.	Wiring problem. Sensor problem. If sensor is not installed this is a normal fault message.
105	Lake/Sea Temp Circuit Low	Temperature Sensor	Sea water temperature sensor is not working properly.	Non-critical - Service engine soon.	Boat-mounted water temperature sensor circuit shorted.	Wiring problem. Sensor problem.
106	Shift Actuator Driver Overtemp	Critical - Shift Actuator	Shift actuator is not working properly.	Return to port immediately - Service engine before next use.	Shift actuator driver within PCM temperature high.	Wiring problem. Shift actuator faulty. Binding linkage.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
107	Shift Actuator Sensor Circuit High	Critical - Shift Actuator	Shift actuator is not working properly.	Return to port immediately - Service engine before next use.	Shift position sensor circuit is faulty.	Wiring problem. Sensor problem.
108	Shift Actuator Sensor Circuit Low	Critical - Shift Actuator	Shift actuator is not working properly.	Return to port immediately - Service engine before next use.	Shift position sensor circuit is faulty.	Wiring problem. Sensor problem.
109	Shift Actuator No Adapt	Shift Actuator	Shift actuator is not working properly.	Non-critical - Service engine soon.	Actuator stalled but not within a valid range.	Check linkage. Shift actuator faulty.
110	Shift Position Switch Fault	Shift	Shift switch is not working properly.	Non-critical - Service engine soon.	Shift switch/neutral switch faulty.	Wiring problem. Switch faulty. Check linkage.
111	ECT Circuit High	Temperature Sensor	Coolant temperature sensor is not working properly.	Non-critical - Service engine soon.	Starboard head coolant temperature sensor circuit open.	Wiring problem. Sensor problem.
112	ECT Circuit Low	Temperature Sensor	Coolant temperature sensor is not working properly.	Non-critical - Service engine soon.	Starboard head coolant temperature sensor circuit shorted.	Wiring problem. Sensor problem.
113	Starboard Tab Circuit High	Sensor	Trim tab sensor is not working properly.	Non-critical - Service engine soon.	Starboard tab sensor circuit open.	Wiring problem. Sensor problem.
114	Starboard Tab Circuit Low	Sensor	Trim tab sensor is not working properly.	Non-critical - Service engine soon.	Starboard tab sensor circuit shorted.	Wiring problem. Sensor problem.
115	Starboard Tab Down Solenoid Output	Trim Tab	Tab down control is not working properly.	Non-critical - Service engine soon.	Problem with trim tab solenoid.	Wiring problem. Sensor problem.
116	Starboard Tab Up Solenoid Output	Trim Tab	Tab up control is not working properly.	Non-critical - Service engine soon.	Problem with trim tab solenoid.	Wiring problem. Sensor problem.
117	Start Solenoid Output	Start System	Engine may not start. The starter solenoid is not working properly.	Non-critical - Service engine soon.	Open circuit to or insufficient current draw on start solenoid/relay.	Wiring problem between ECM and start solenoid/relay. Faulty solenoid.
118	Steering Position Circuit High	Sensor	Steering angle sensor is not working properly.	Non-critical - Service engine soon.	Steering sensor circuit shorted.	Wiring problem. Sensor problem. Fault will appear in freeze frame if sensor is not wired into Smartcraft.
119	Steering Position Circuit Low	Sensor	Steering angle sensor is not working properly.	Non-critical - Service engine soon.	Steering sensor circuit open.	Wiring problem. Sensor problem.
120	TPS 1 Circuit High	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI sensor circuit shorted.	Wiring problem. Faulty sensor inside of ETC.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
121	TPS 1 Circuit Low	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI sensor circuit open.	Wiring problem. Faulty sensor inside of ETC.
122	TPS 1 Range High	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI above the normal expected range.	Faulty sensors inside of ETC.
123	TPS 1 Range Low	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI below the normal expected range.	Faulty sensors inside of ETC.
124	TPS 1 No Adapt	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	Outside valid range when trying to adapt. Adapt occurs when exiting crank on way to run.	Faulty sensors inside of ETC.
125	TPS 2 Circuit High	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI sensor circuit shorted.	Wiring problem to ETC connectors. Faulty sensor inside of ETC.
126	TPS 2 Circuit Low	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI sensor circuit open.	Wiring problem. Faulty sensor inside of ETC.
127	TPS 2 Range High	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI above the normal expected range.	Faulty sensors inside of ETC.
128	TPS 2 Range Low	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	TPI below the normal expected range.	Faulty sensors inside of ETC.
129	TPS 2 No Adapt	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	Outside valid range when trying to adapt. Adapt occurs when exiting crank on way to run.	Faulty sensors inside of ETC.
130	Trim Sensor Circuit High	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	Trim sensor circuit shorted.	Wiring problem. Sensor problem.
131	Trim Sensor Circuit Low	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	Trim sensor circuit open.	Wiring problem. Sensor problem.
132	Crank Position Sensor Fault	Critical - Engine Sensor	Crankshaft position sensor is not working properly.	Return to port immediately - Service engine before next use.	With this failure, engine will not run. Variable reluctance sensor (crank position sensor).	Wiring problem. Sensor problem.
133	Power 1 Volts (5VDC) Low	Critical - Voltage	Sensor power supply voltage is low.	Return to port immediately - Service engine before next use.	Supplies power to all sensors (+5v).	Excessive current draw on the +5 VDC circuit. Circuit/sensor shorted to ground.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
134	Abusive Overspeed - Stage 1	Engine Overspeed	Excessive engine speed. Possible causes: Trim angle or improper propeller.	Non-critical - Service engine soon.	Level 1 of overspeed exceeded.	Prop too small. Too much trim. Too high on transom. Too much vent in prop. Too much throttle in neutral. Gearcase problem. Prop damaged.
135	Abusive Overspeed - Stage 2	Engine Overspeed	Excessive engine speed. Possible causes: Trim angle or improper propeller.	Non-critical - Service engine soon.	Level 2 of overspeed exceeded.	Prop too small. Too much trim. Too high on transom. Too much vent in prop. Too much throttle in neutral. Gearcase problem. Prop damaged.
138	ECM Memory Fault	Critical - Engine Control Unit	Engine control unit is not working properly.	Return to port immediately - Service engine before next use.	ECM memory is corrupted.	ECM faulty.
148	ESC and Neutral Switch Position Fault	Shift	Shift controller is not working properly.	Non-critical - Service engine soon.	ESC actuator's determination of its position and neutral switch position do not agree.	Harness connection to neutral switch faulty, or faulty neutral switch.
149	ETC Idle Range Fault	Critical - Engine Sensor	Electronic throttle controller is not working properly.	Return to port immediately - Service engine before next use.	ETC out of range for the idle position.	Wiring problem. Debris in ETC. Faulty ETC. Air leak in induction system.
150	Multiple CAN Comm. Faults	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	Communication between VesselView and PCM has been lost. Discrepancy between CAN P and CAN X	Wiring problem CAN P and CAN X. Lost terminator connection.
151	Fuel Pump Relay Circuit	Critical - Fuel Pump	Fuel Pump is not working properly.	Return to port immediately - Service engine before next use.	Open circuit to fuel pump.	Wiring problem. Connector problem. Failed fuel pump.
152	IAC Output	Critical - Idle Air Valve	Idle air controller is not working properly. Open throttle slightly to start engine.	Return to port immediately - Service engine before next use.	Open circuit to IAC.	Wiring problem. Connector problem. Failed IAC.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
153	Drive Lube Bottle Low	Drive Lube Low	Drive lube is low. Check level and refill as needed. Continued operation may cause damage.	Non-critical - Service engine soon. - Refer to Owner's manual for service procedure.	Drive lube switch is active.	Drive lube low. Faulty lube switch.
154	Mass Airflow too High	Excessive Airflow	Mass air flow calculation is above limit.	Non-critical - Service engine soon.	Mass airflow calculation not correct.	Calibration problem.
158	Port EMCT Circuit High	Temperature Sensor	Port exhaust manifold coolant temperature sensor is not working properly.	Non-critical - Service engine soon.	Port exhaust manifold temperature circuit open.	Wiring problem. Sensor problem.
159	Port EMCT Circuit Low	Temperature Sensor	Port exhaust manifold coolant temperature sensor is not working properly.	Non-critical - Service engine soon.	Port exhaust manifold temperature circuit shorted.	Wiring problem. Sensor problem.
160	Port EMCT Overheat	Critical - Manifold Temp	Port exhaust manifold temperature is too high.	Return to port immediately - Service engine before next use.	Port exhaust manifold temperature high.	Cooling problem.
163	CAN Comm. Fault Type 5	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Wiring problem on the CAN system.
176	ESC / ERC Position Difference	Shift	A shift fault has occurred	Return to port immediately - Service engine before next use.	ESC actuator's determination of its position and commanded position do not agree.	Worn linkage. Faulty ESC. Faulty ERC.
177	Starboard EMCT Circuit High	Temperature Sensor	Starboard exhaust manifold coolant temperature sensor is not working properly.	Non-critical - Service engine soon.	Starboard exhaust manifold temperature circuit open.	Wiring problem. Sensor problem.
178	Starboard EMCT Circuit Low	Temperature Sensor	Starboard exhaust manifold coolant temperature sensor is not working properly.	Non-critical - Service engine soon.	Starboard exhaust manifold temperature circuit shorted.	Wiring problem. Sensor problem.
179	Starboard EMCT Overheat	Critical - Manifold Temp	Starboard exhaust manifold temperature is too High.	Return to port immediately - Service engine before next use - Refer to Owner's manual for service procedure.	Starboard exhaust manifold temperature high.	Cooling problem.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
180	MAP/TPI Difference Fault	Engine Sensor	Secondary throttle position is not working properly.	Non-critical - Service engine soon.	Both TPIs are functioning, but MAP sensor calculations do not agree. Suspect MAP sensor to be faulty.	MAP sensor outside of expected operating range. Abnormal airflow in intake.
181	All TPI Sensors	Critical - Engine Sensor	Throttle Position Sensors do not agree.	Return to port immediately - Service engine before next use.	MAP does not agree with either TPI. Power off the ETC.	Wiring problem to ETC. Sensor problem.
182	TPS 1 Difference Fault	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	MAP sensor range = TPI2, but TPI1 does not agree.	Wiring problem to ETC. Sensor problem.
183	TPS 2 Difference Fault	Engine Sensor	Throttle positioning sensor is not working properly.	Non-critical - Service engine soon.	MAP sensor range = TPI1, but TPI2 does not agree.	Wiring problem to ETC. Sensor problem.
184	Trim Down Relay Output	Trim Down	Engine may not trim down. The trim down relay is not working properly.	Non-critical - Service engine soon.	Trim down circuit faulty.	Wiring problem. Faulty relay coil.
185	Trim Up Relay Output	Trim Up	Engine may not trim up. The trim up relay is not working properly.	Non-critical - Service engine soon.	Trim up circuit faulty.	Wiring problem. Faulty relay coil.
186	CAN Comm. Fault Type 7	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Problem on the CAN system.
187	CAN Comm. Fault Type 8	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Wiring problem on the CAN system.
188	Primary Demand to Redundant Diff	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN P (1) not equal to CAN X (2) cross check failure.	Faulty potentiometers in ERC.
189	Demand Cross Check Difference	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	Command module not equal to PCM cross check of demand value.	Incorrect positions used when configuring levers at command module, faulty command module or PCM.
190	Shift Cross Check Difference	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	Command module not equal to PCM cross check of shift position.	Incorrect positions used when configuring levers at command module, faulty command module or PCM.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
191	Fuel Level 2 Circuit High	Tank 2 Level	Level sender for tank 2 is not working properly.	Non-critical - Service engine soon.	Secondary boat-mounted fuel tank sensor circuit open.	Wiring problem. Sensor problem.
192	Fuel Level 2 Circuit Low	Tank 2 Level	Level sender for tank 2 is not working properly.	Non-critical - Service engine soon.	Secondary boat-mounted fuel tank sensor circuit shorted.	Wiring problem. Sensor problem.
193	Shift Anticipate Switch Fault	Shift	A shift fault has occurred.	Non-critical - Service engine soon.	Shift interrupt switch active at incorrect time.	Wiring problem. Mechanical linkage problem. Faulty shift switch.
194	ESC Timeout Fault	Shift	A shift fault has occurred.	Non-critical - Service engine soon.	Shift actuator has not physically moved with respect to the control lever demand position.	Linkage problem. Faulty ESC. Wiring problem.
195	Thermostat Fault	<i>not available</i>	<i>not available</i>	<i>not available</i>	<i>not available</i>	<i>not available</i>
196	Transmission Overheat	Transmission Overtemp	Transmission is overheating. Key engine off and allow to cool. Restart engine. Refer to the Owner's manual for more information.	Non-critical - Service engine soon.	Transmission temperature high.	Wiring problem. Sensor problem.
209	Engine Voltage Low	Critical - Engine Voltage Low	Engine Actuator voltage is low.	Return to port immediately - Service engine before next use.	Supplies power to all drivers (+12v).	Faulty or low battery condition.
210	Overspeed in Neutral	Engine overspeed	Engine RPM is above specified limit with engine in neutral.	Reduce engine RPM.	Allowable overspeed limit in neutral exceeded.	Faulty shift switch. Engine exceeded specified RPM in neutral.
211	Overspeed in Reverse	Engine overspeed	Engine RPM is above specified limit with engine in reverse.	Reduce engine RPM or trim engine down.	Allowable overspeed limit in reverse exceeded.	Engine exceeded specified RPM limit in reverse gear.
212	SmartStart Failed. No RPM Detected	Start Sequence Aborted	Attempted start was not successful. Refer to Owner's manual for more information.	Key engine off and restart. If the condition persists Seek Assistance. Return to port immediately - Service engine before next use.	No engine RPM detected, no starter engagement.	Starter failed to engage. Weak battery. Open circuit to start solenoid. DTS power wires connected at starter solenoid, not battery. CPS circuit problem.
215	CAN Comm. Fault Type 9	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Wiring problem on the CAN X (02) system.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
216	CAN Comm. Fault Type 10	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Wiring problem on the CAN X (2) system.
217	Power 2 (5 VDC) Volts Low	Voltage	Sensor power voltage is low.	Non-critical - Service engine soon.	Supplies power to all SmartCraft sensors (+5v).	Excessive current draw on the +5 VDC circuit. Paddle wheel harness shorted. SmartCraft connector corroded.
218	Helm ADC Check	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	Discrepancy between the DTS command module and the PCM.	Wrong DTS command module for engine model. Faulty DTS command module. Incorrect PCM hardware. Wiring problem.
219	ESC Loss of Control	Shift	Return handle to neutral and key engine off. Restart and shift engine.	Return to port immediately - Service engine before next use.	ESC in gear position other than commanded by ERC.	Potentiometers in electronic shift actuator are questionable. Wiring to actuator could be bad. Engine manually put into gear.
226	CAN Comm. Fault Type 11	Critical - Communication Error	There is a communication problem with the SmartCraft control system.	Return to port immediately - Service engine before next use.	CAN bus	Communication problem on the CAN system.
227	Hydraulic Shift Pressure Sensor A Circuit Low	Engine Sensor	Shift pressure sensor is not working properly.	Non-critical - Service engine soon.	Pressure sensor A open. PCM cannot use pressure sensor A to determine neutral/in-gear state of transmission.	Wiring problem. Sensor problem.
228	Hydraulic Shift Pressure Sensor A Circuit High	Engine Sensor	Shift pressure sensor is not working properly.	Non-critical - Service engine soon.	Pressure sensor A shorted. PCM cannot use pressure sensor A to determine neutral/in-gear state of transmission.	Wiring problem. Sensor problem.
229	Hydraulic Shift Pressure Sensor A Circuit Undefined	Engine Sensor	Shift pressure sensor is not working properly.	Non-critical - Service engine soon.	Pressure sensor A detects that the transmission is not in neutral or in-gear. This fault will also detect if the transmission is in-gear while attempting to start engine.	Low transmission fluid. Sticky valve in transmission. Bad electrical solenoid on valve body. Wiring problem. Sensor problem.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
230	Hydraulic Shift Pressure Sensor B Circuit Low	Engine Sensor	Shift pressure sensor is not working properly.	Non-critical - Service engine soon.	Pressure sensor B open. PCM cannot use pressure sensor A to determine neutral/in-gear state of transmission.	Wiring problem. Sensor problem.
231	Hydraulic Shift Pressure Sensor B Circuit High	Engine Sensor	Shift pressure sensor is not working properly.	Non-critical - Service engine soon.	Pressure sensor B shorted. PCM cannot use pressure sensor A to determine neutral/in-gear state of transmission.	Wiring problem. Sensor problem.
232	Hydraulic Shift Pressure Sensor B Undefined	Engine Sensor	Shift pressure sensor is not working properly.	Non-critical - Service engine soon.	Pressure sensor B detects that the transmission is not in neutral or in-gear. This fault will also detect if the transmission is in-gear while attempting to start engine.	Low transmission fluid. Sticky valve in transmission. Bad electrical solenoid on valve body. Wiring problem. Sensor problem.
233	Hydraulic Shift System Fault	Engine Sensor	Shift system is not working properly.	Non-critical - Service engine soon.	Both pressure sensors determine an in-gear state.	Low transmission fluid. Sticky valve in transmission. Bad electrical solenoid on valve body. Wiring problem. Sensor problem.
234	Hydraulic Shift System Pressure too High	Engine Sensor	Shift pressure is high.	Non-critical - Service engine soon.	The pressure sensors determine that the fluid pressure in the transmission is too high.	Dirty filter in transmission. High transmission fluid. Sticky valve in transmission. Wiring problem. Sensor problem.
235	Hydraulic Shift System Position Fault	Engine Sensor	Shift fault has occurred. return the handle to neutral and retry shift command.	Non-critical - Service engine soon.	The pressure sensors determine that the solenoid being activated is incorrect.	Helm not set correctly. The wiring for the solenoids are switched. The wiring for the pressure sensors are switched. Wiring problem. Sensor problem.
236	Emergency Stop Activated	Emergency Stop	Emergency stop has been activated. Check lanyard	Non-critical - Service engine soon. - Refer to Owner's manual for service procedure.	Emergency stop performed.	Reattach the lanyard and restart the engine.
238	Overspeed in Trailer Mode	Engine Overspeed	Engine RPM is above specified limits in trailer position.	Reduce engine RPM or trim engine down.	Engine RPM is above the allowable limit in trailer position.	High RPM in trailer range. Lower trim.

Fault #	CDS Fault Message	System Tach or VesselView Short Text	System Tach or VesselView Long Text	Action Text	Fault Explanation	Possible Root Causes
239	Underwater Impact	Underwater Impact	Underwater impact has occurred. Inspect the engine for damage.	If damage has occurred - See dealer soon.	Fast trim sensor movement.	There has been an underwater impact.
240	Low Battery	Critical - Low Voltage	Battery voltage is below normal limit. Turn off unnecessary loads, increase engine RPM and check battery connections.	Return to port immediately - Service engine before next use.	Low battery voltage.	Excessive battery draw. Corroded circuits. Failed alternator or battery.
241	Manifold Temp Overheat	Overtemp	Charge air temperature is above specified limits. Reduce throttle demand.	Non-critical - Service engine soon.	Charge air temperature is above the allowable limit.	Reduce throttle demand.
242	Fuel Vent Purge Valve	Purge Valve	Fuel purge valve is not working properly.	Non-critical - Service engine soon.	Fuel vent valve is not opening.	Wiring problem. Faulty valve.
243	Center Tab Circuit High	Sensor	Trim tab sensor is not working properly.	Non-critical - Service engine soon.	Trim tab sensor input is high.	Trim sensor has failed or is not connected.
244	Center Tab Circuit Low	Sensor	Trim tab sensor is not working properly.	Non-critical - Service engine soon.	Trim tab sensor input is low.	Trim sensor has failed or is not connected.
246	Boost Limit due to SC Temp	Engine Power Limited	Engine power is limited due to supercharger overheat.	Non-critical - Service engine soon.	Supercharger is overheating and engine power is limited.	Engine oil low. Faulty sensor. High ambient temperature
247	Boost Limit due to Knock	Engine Power Limited	Engine power is limited due to knock system.	Non-critical - Service engine soon.	Engine is detonating and engine power is limited.	Poor quality fuel.

Troubleshooting Charts

System Series Instrumentation

VesselView, System Monitor, System Tachometer and Speedometer

Symptom	Potential Cause	Possible Solution
RPM and engine data are displayed when the engines are not running and the ignition key is on.	Monitor is in simulator mode.	Exit simulator mode.
Link gauges are inoperative, but System gauges function normally.	Incorrect harness installation.	Ensure that the Link gauge harness is connected to a System gauge and not a junction box.
Failed CAN communication.	Incorrect termination resistor placement.	Confirm termination resistor placement for vessel engine and helm configuration. Refer to SmartCraft Instrumentation .
	A short or break in the CAN wiring.	Check resistance across the blue and white CAN wires. Correct resistance values: 60 Ω with two termination resistors installed, 120 Ω with one installed. Correct any wiring issues found.
No or incorrect fuel gauge reading.	Both an analog fuel gauge and a SmartCraft fuel gauge are installed.	Only use one type of fuel gauge. Mixing analog and SmartCraft fuel gauges will cause a ground loop through the 5-volt transducer bus and could damage the ECM.
The engine and warning bell icons display for several seconds while powering down, but no fault codes are present.	The engine is still in break-in period.	Follow the correct engine break-in procedure.
	The audio alarm is disabled.	Enable the audio alarm system.
The fuel and bell icon display without an audio warning.	The fuel gauge requires calibration.	Follow the correct fuel gauge calibration procedure.
Dual engine application instrumentation displays erratic or erroneous data.	CAN bus electrical feedback due to a wiring configuration or installation error.	Correct any wiring configuration or installation errors.

VesselView

Symptom	Potential Cause	Possible Solution
Fuel tank shows full all of the time.	Fuel calibration was begun with an empty tank and fuel was never added before exiting the calibration procedure.	Follow the correct fuel gauge calibration procedure.
Calibration settings are not saved.	The system was not powered down (ignition key off) after each calibration procedure.	Restart the calibration process ensuring that the system is powered down (ignition key off) and the display goes blank after each calibration procedure.
GPS display does not work or displays erroneous and erratic information.	Incorrect harness installation.	Check that all harness connectors are free of contamination and locked in place.
	The GPS system is incorrectly configured.	Switch to NMEA 0183 v1.5 or turn off GSV sentence. (Refer to the operating instructions provided by the GPS unit's manufacturer.)
The speed display is erratic.	GPS speed input is turned on, but a GPS unit is not connected.	Disable the instrument GPS speed input.

System Tachometer and System Speedometer

Symptom	Potential Cause	Possible Solution
The LCD displays "data bus error."	Incorrect termination resistor placement.	Confirm termination resistor placement for vessel engine and helm configuration. Refer to SmartCraft Instrumentation .
	A short or break in the CAN wiring.	Check resistance across the blue and white CAN wires. Correct resistance values: 60 Ω with two termination resistors installed, 120 Ω with one installed. Correct any wiring issues found.
Instrument is locked up.	Perform a master reset.	Hold both "Troll –" and "Troll +" until the two bars on the graphic display meet.
Link gauges are inoperative.	Incorrect harness installation.	Check that all harness connectors are free of contamination and locked in place.
		Ensure that the tach harness link connector is connected to the gauge, not the junction box.
The speed display is erratic.	GPS speed input is turned on, but a GPS unit is not connected.	Disable the instrument GPS speed input.

General Troubleshooting Information

10-pin CAN connector wiring	A = red, B = black, C = yellow (gauge end only), D = blue, E = white, F = purple
Speed transducer 4-pin plug wiring	A = black, B = blue, C = yellow, D = white
Depth transducer wiring, MerCruiser side	A = black, B = white/black, C = white/purple, D=red
Depth transducer 4-pin plug wiring	A = black, B = blue, C = white, D = red
Can a stand-alone System Speedometer be used?	No. A System Speedometer must be used with a master System series speedometer or viewer.
Can stand-alone SC1000 Link gauges be used?	No. A System Speedometer must be used with a master System series speedometer or viewer.
Can both an analog fuel gauge and a SmartCraft fuel gauge be installed?	No. This will cause a ground loop through the 5-volt transducer bus and could damage the ECM.
Is there any special wiring need for dual-engine applications?	Yes. The actual configuration will depend on several variables. Refer to the appropriate section of this service manual.
After a Master Reset on a dual engine application, one of the tachometers indicates that there is no starboard engine.	1. Make sure both engines are configured properly. 2. Unplug any Link gauges connected to that tachometer. The Link gauges can temporarily freeze the system during a master reset.
The gauge display shows "Multiple Starboard Engines."	Both engine ECMs are set to starboard. Correct the issue with the CDS G3 tool.
The gauge display shows "No Starboard Engine."	Both engine ECMs are set to port. Correct the issue with the CDS G3 tool.
There is no tachometer display on the speedometer.	The System Tachometer needs to be programmed before the System Speedometer.
How is fuel-used data reset?	Press the "Mode" and "Troll" buttons on the System Speedometer simultaneously.

Removal and Installation

Section 2A - Removal

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**2
A**

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Preparation

1. Remove the boat from the water.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

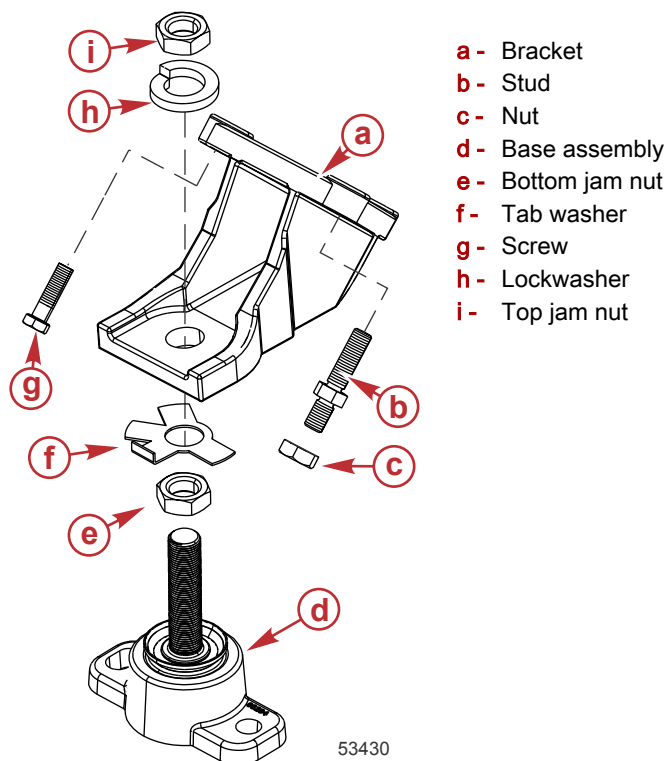
⚠ CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

2. Disconnect the battery cables from the battery.
NOTE: The sterndrive must be removed before removing the engine.
3. Remove the sterndrive. (Refer to the appropriate sterndrive service manual.)
4. Remove the engine cover.

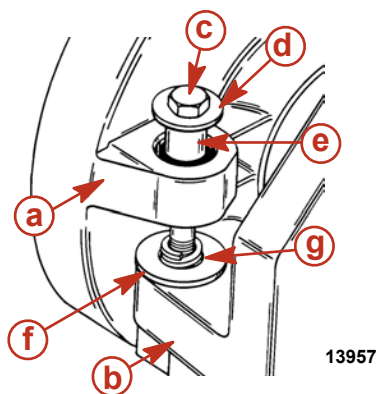
Engine Mounts

Front Engine Mounts



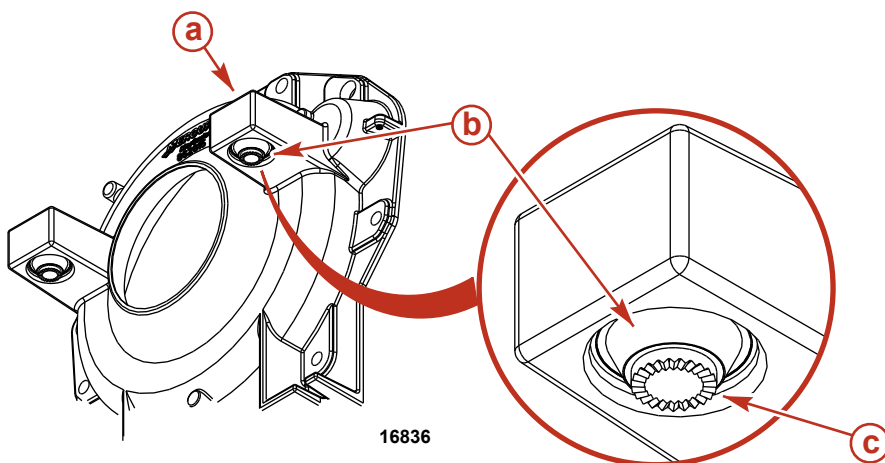
- a - Bracket
- b - Stud
- c - Nut
- d - Base assembly
- e - Bottom jam nut
- f - Tab washer
- g - Screw
- h - Lockwasher
- i - Top jam nut

Rear Engine Mounts



Rear engine mount with lockwasher

- a - Rear engine mount
- b - Inner transom plate mount
- c - Bolt
- d - Washer
- e - Spacer
- f - Fiber washer
- g - Double-wound lockwasher



Rear engine mount without lockwasher and with knurled edge on bottom

- a - Painted end (not visible)
- b - Mount bottom
- c - Knurled edge

Sterndrive (MCM) Rear Engine Mount Change

Starting serial number: 0M660000

Do not use double-wound lockwashers on the inner transom plate with rear mounts that have a knurled edge.

Disconnecting the Fluid Systems

Fuel Hose

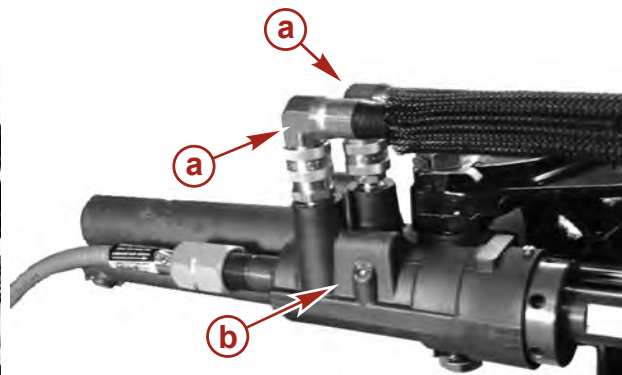
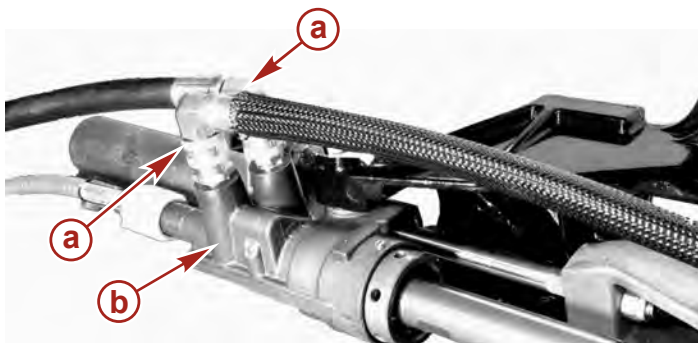
WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. Close the fuel shut-off valve, if equipped.
2. Loosen the hose clamp retaining the fuel line to the fuel inlet.
3. Disconnect and plug the fuel line to prevent fuel in the line from leaking into the bilge.

Steering Hoses

1. Disconnect the hydraulic hoses from the steering actuator.



16225

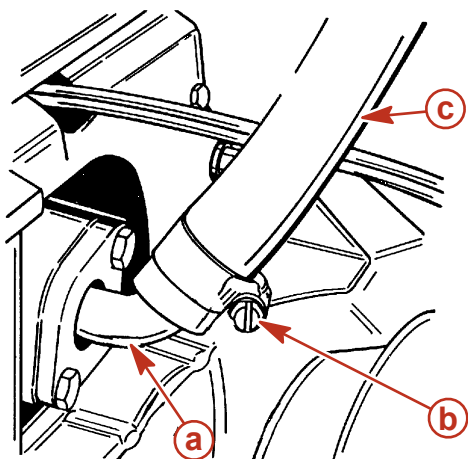
Typical power-assisted steering connections

- a** - Hydraulic hoses
- b** - Power-assisted steering actuator

2. Plug or cap all open fittings to prevent contamination and loss of fluid.

Seawater Hoses

1. On Alpha sterndrive models without a seawater extension hose assembly connection, disconnect the seawater inlet hose from the water inlet tube on the transom.



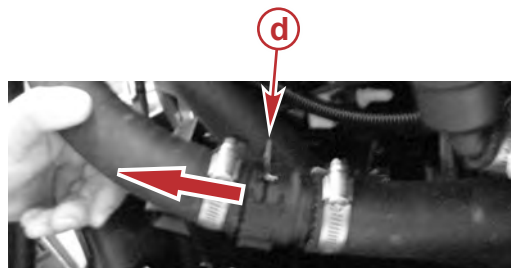
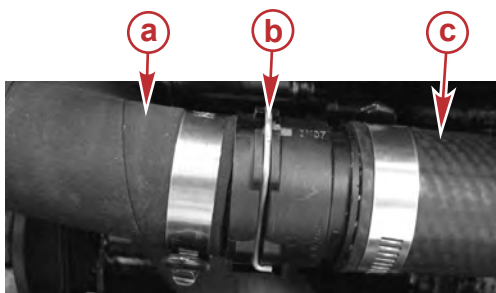
Alpha drive

- a** - Water inlet tube
- b** - Hose clamp
- c** - Seawater inlet hose

7802

2. On Bravo sterndrive models with a seawater extension hose assembly connection, disconnect the seawater extension hose quick-connect fitting from the seawater inlet hose on the seawater pump.

- a. Lift the retainer clip on the quick-connect fitting to the open position.



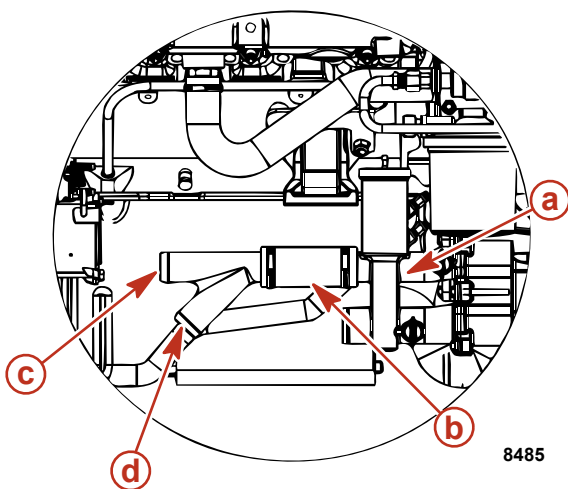
49485

- a - Extension hose (to seawater source)
- b - Retainer clip on quick-connect fitting—closed position
- c - Seawater inlet hose to engine seawater pump
- d - Retainer clip on quick-connect fitting—open position

- b. Remove the wire-reinforced seawater inlet extension hose from the inlet hose attached to the seawater pump.

NOTE: Do not remove the inlet hose from the seawater pump.

3. On Bravo models with closed cooling, where additional water inlets are used, disconnect the seawater inlet hoses from the Y-fitting.



8485

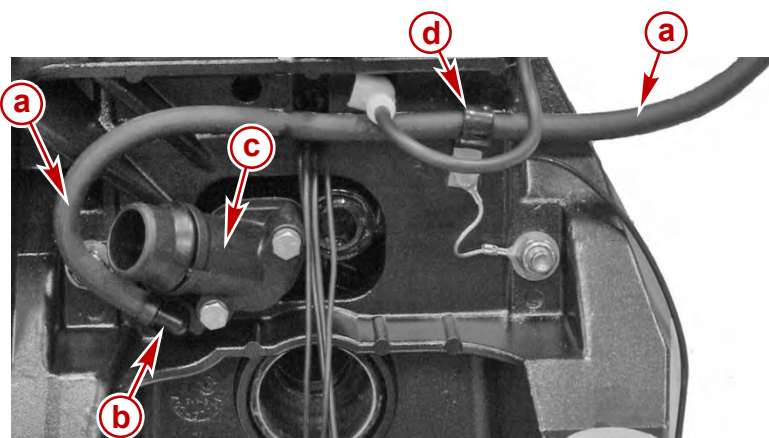
Typical

- a - Engine seawater pump
- b - Hose, 10 cm (4 in.) from the seawater pump inlet to the Y-fitting port
- c - Y-fitting port to water inlet at transom
- d - Y-fitting port to through-the-hull or through-the-transom seawater pickup

Gear Lube Monitor

1. Disconnect the gear lube monitor from the transom.

NOTE: The quick disconnect shown below is located at the transom. Some models have a quick-disconnect fitting in the gear lube monitor hose closer to the engine. It may be more convenient to disconnect the hose at this alternate location.



21623

Typical Bravo drive connection, Alpha similar

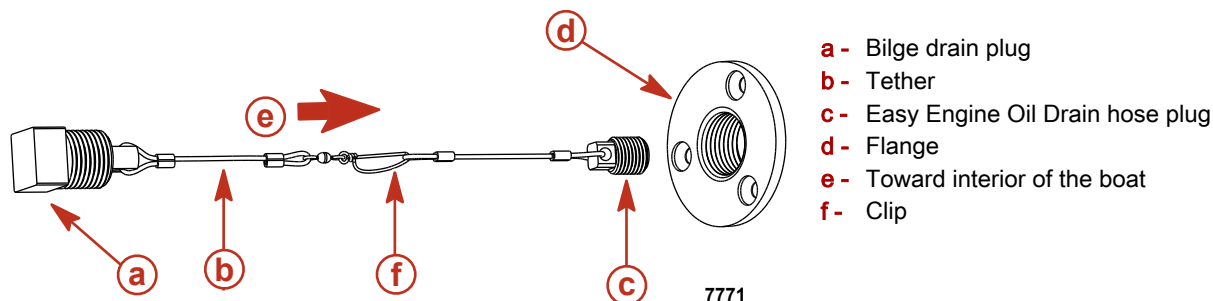
- a - Hose
- b - Quick-disconnect 90° fitting
- c - Seawater inlet fitting
- d - J-clip

2. Place the hose out of the way.

Oil Drain Hose (if Equipped)

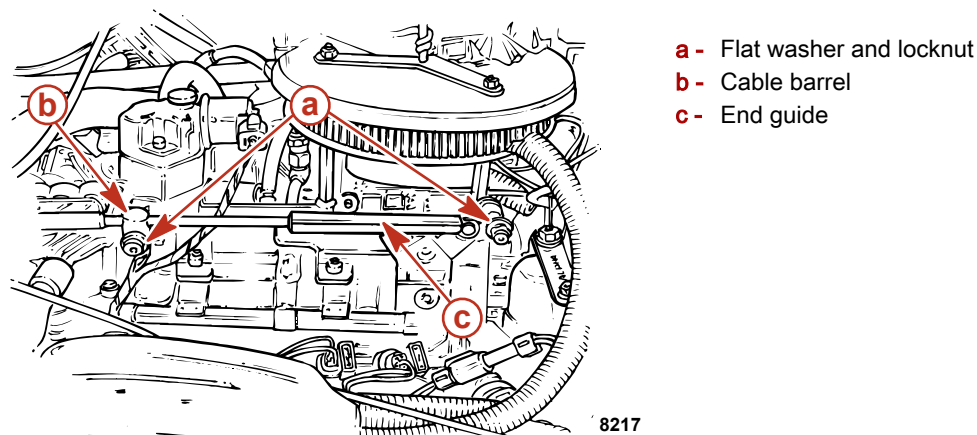
If the engine is equipped with an Easy Engine Oil Drain system, disconnect the oil drain hose as follows:

1. Remove the bilge drain plug.
2. Disconnect the plug tether from the Easy Engine Oil Drain hose plug at the clip.
3. Using a cable tie or other means, secure the hose to the engine in a position where it will not be in the way of the engine removal process.



Disconnecting the Throttle Cable

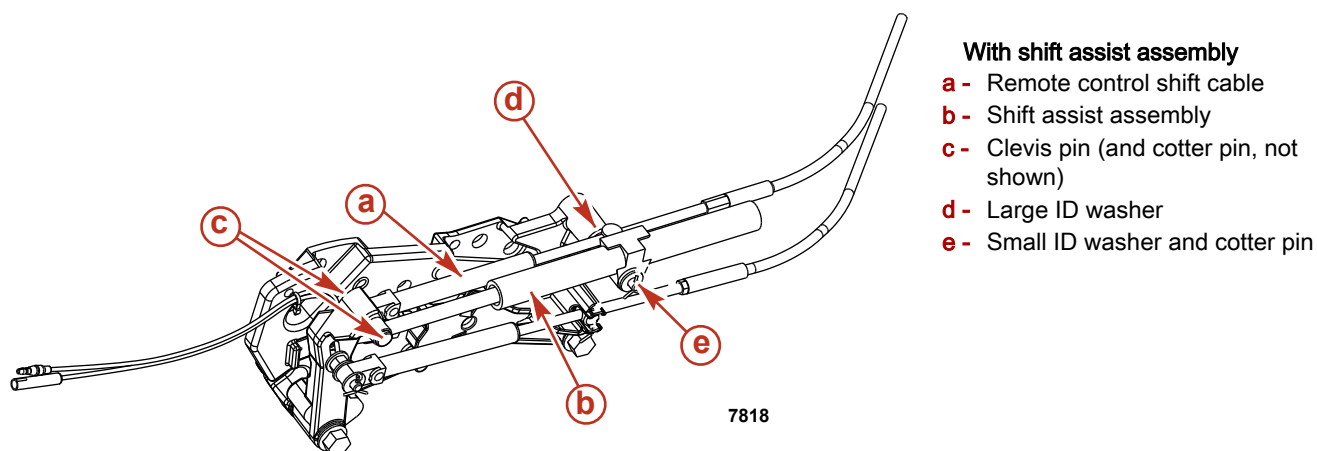
1. Disconnect the throttle cable. Retain the fasteners.

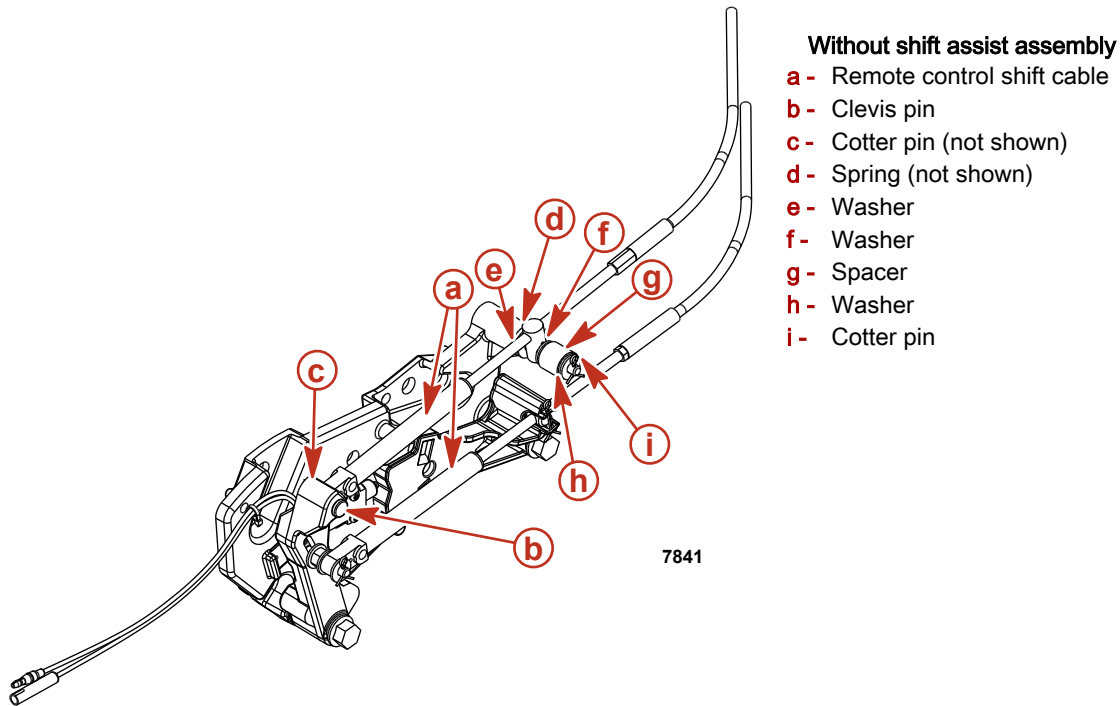


2. Place the cable out of the way.

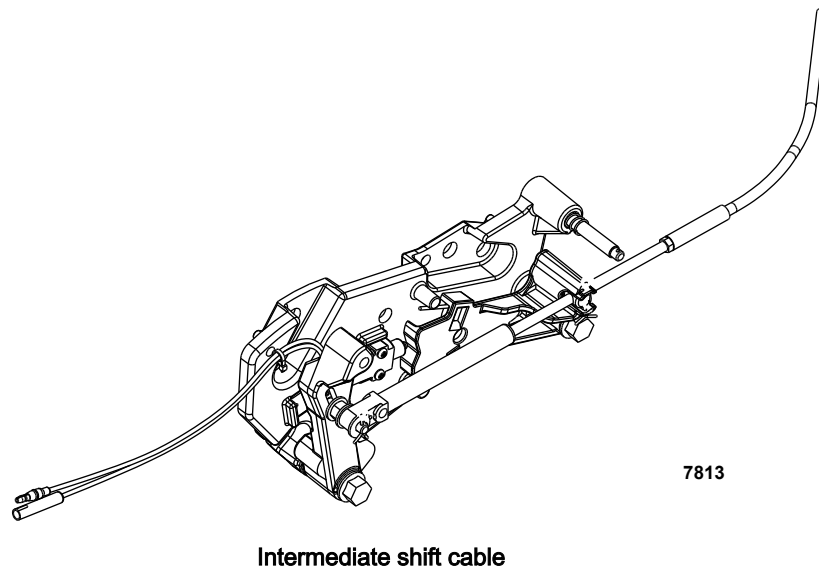
Disconnecting the Shift Cable

1. Disconnect the remote control shift cable from the shift plate and retain the hardware.



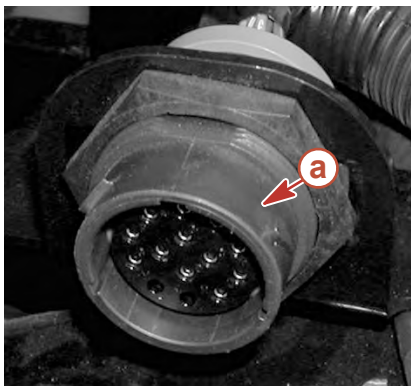


2. Disconnect the intermediate shift cable from the shift plate, and retain the hardware.



Disconnecting the Electrical Components

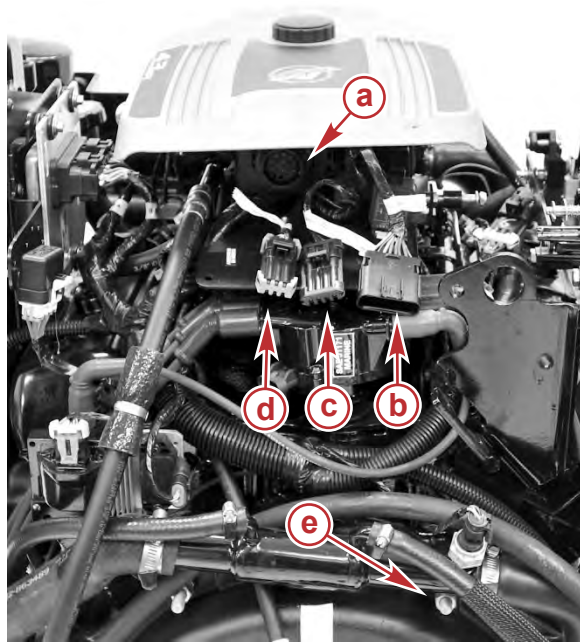
1. Turn the locking ring on the 14-pin connector, and remove the boat harness from the engine harness connector.



- a** - 14-pin engine harness connector

Removal

2. If equipped, disconnect the transom harness 16-pin connector from the engine harness.
3. If equipped, disconnect the paddle wheel and tank level connector from the engine harness.
4. If equipped, disconnect the depth transducer from the data link connector (DLC) on the engine harness.
5. Disconnect any grounding wires and accessories that are connected to the engine.

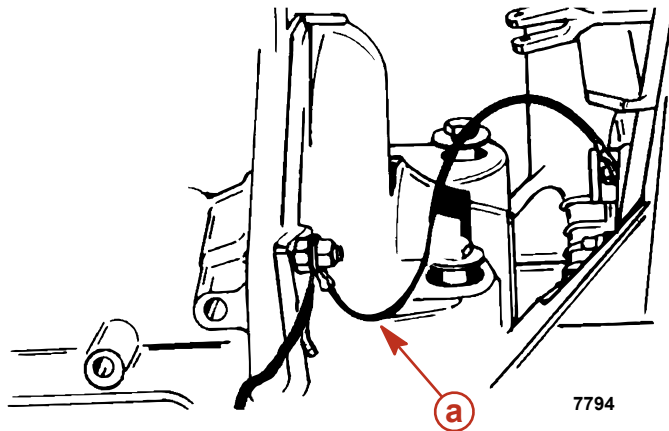


53586

- a - 14-pin connector
- b - 16-pin transom harness connector
- c - DLC connector
- d - Paddle wheel and tank level connector
- e - Grounding stud

Continuity Wire Removal

Disconnect the continuity circuit wire that runs from the engine to the transom assembly.

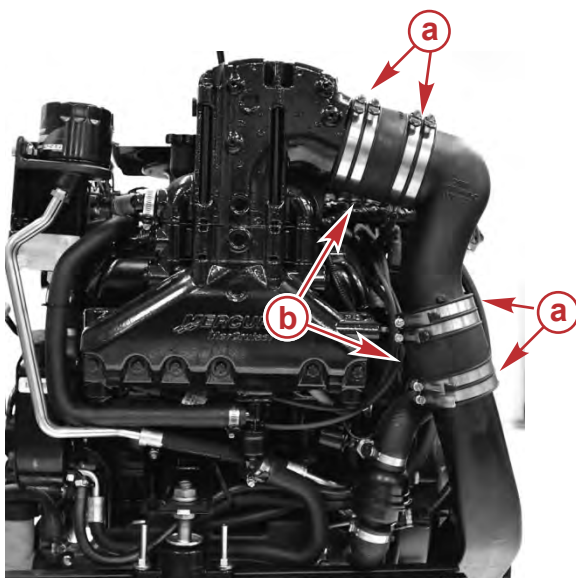


7794

- a - Continuity wire

Removing the Engine

1. Loosen the exhaust tube hose clamps on the exhaust Y-pipe.



53067

- a** - Two hose clamps at each exhaust connection point
b - Exhaust tubes

⚠ CAUTION

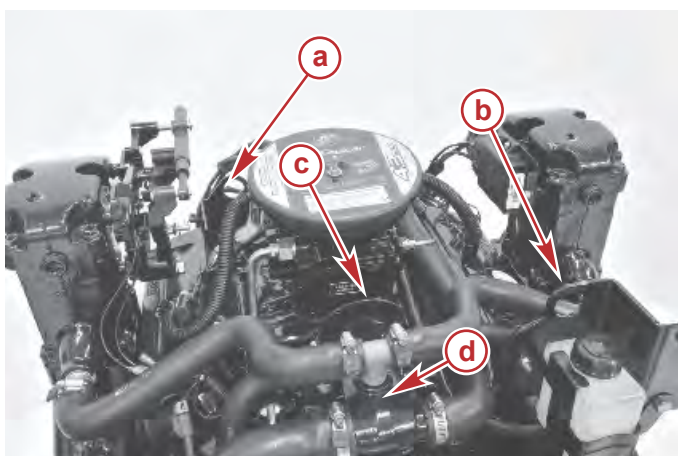
Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

IMPORTANT: Engine compartment size may necessitate the removal of additional components.

2. On models with a driveshaft extension:
 - a. Remove the bolts and nuts securing the engine-end top driveshaft shield.
 - b. Remove the top driveshaft shield.
 - c. For reference during assembly, scribe a mark across the yokes for the driveshaft U-joint and the bearing support U-joint (output flange).
 - d. Remove the bolts securing the driveshaft to the bearing support U-joint yoke.
 - e. Separate the driveshaft from the bearing support U-joint yoke.

IMPORTANT: The center lifting eye on top of the thermostat housing is used for engine alignment only. Do not use the center lifting eye to lift the engine.

3. Support the engine with a suitable sling through the lifting eyes on the engine.



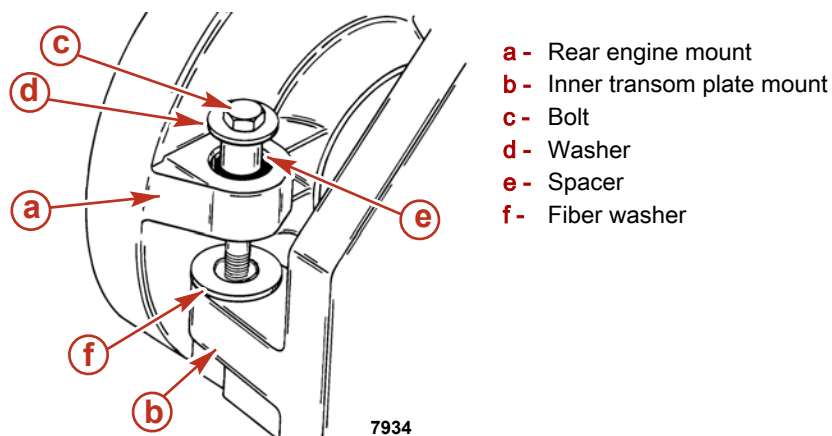
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TKS engine shown

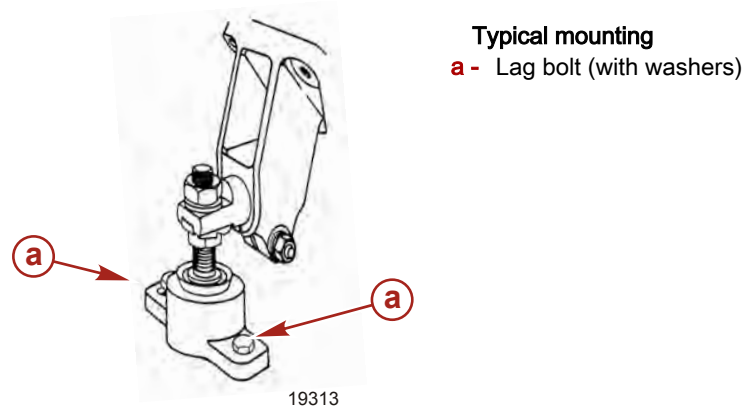
- a** - Rear lifting eye
b - Front lifting eye
c - Center lifting eye—for alignment only
d - Thermostat housing

Removal

4. Remove the two rear engine mount bolts.



5. Remove the fasteners (for example, lag bolts) that hold the front mounts to the engine bed. Retain the fasteners and hardware.



6. Carefully remove the engine. Do not damage the power-assisted steering control valve, pulleys, brackets, flame arrestor, cover, or related engine hardware and components.

Removal and Installation

Section 2B - Installation

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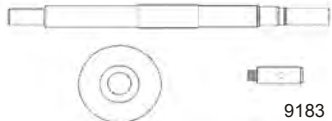
**2
B**

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Coupler splines	8M0071842
	Battery connection sealant	Battery terminal connections	Obtain Locally
	Perfect Seal	Engine mounting hardware threads and nuts	92-34227Q02
	Liquid Neoprene	Battery terminals	92- 25711 3
		All electrical connections	
		Exposed terminals and connections	

Special Tools

Alignment Tool Assembly	91-805475A 1
 9183	Aligns the engine and the sterndrive unit during installation.

Shift Cable Adjustment Tool	91-12427T
 9186	Attaches over the shift cable, and aids in proper shift cable adjustment at the shift plate.

Dual Water Pick-up Flush Seal Kit	91-881150K 1
 9194	Blocks off the front water inlet holes on the dual water inlet gearcases.

Flushing Attachment	91-44357Q 2
 9192	Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine.

Flushing Kit	91-849996T 1
 9195	Use for flushing gearcases with low water inlets.

Torque Specifications

NOTE: Securely tighten all fasteners not listed below.

Description	Nm	lb-in.	lb-ft
Speedometer pickup barb fitting	1.5	13	–
Exhaust pipe plate	34	–	25
Exhaust block-off plate screw	34	–	25
Power steering hydraulic hose fittings	34	–	25
Power trim pump hose fittings	14	125	–
Rear engine mounting bolts	47	–	35
Steering cable coupler nut	47	–	35
Pivot bolts	34	–	25
Water inlet block-off screws	5	45	–
Fuel inlet fitting	Hand-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.		
Trim cylinder bolt	23	–	17
Trim cylinder end cap	61	–	45
Seawater inlet nut	47	–	35
Exhaust tube clamps	4	35	–
Hose clamps	4	35	–
Mounting clip screw	12	108	–
Fuel line connectors	23	–	17
Positive (+) battery cable nut (starter solenoid)	8–11	71–97	–
Flame arrestor bolts	2.8	25	–

Preparation

NOTE: Refer to **Mercury MerCruiser Service Manual #14 (Alpha)**, or **Mercury MerCruiser Service Manual #39 (Bravo)**, or the appropriate engine installation manual for transom assembly, trim pump, and sterndrive installation instructions.

1. Connect the battery cables to the engine. Observe the following:
 - a. Ensure that the grounding stud and starter solenoid terminal are free of paint or any other material that could cause a poor electrical connection.
 - b. Install the positive (+) battery cable directly to the large starter solenoid stud. Tighten to the specified torque.

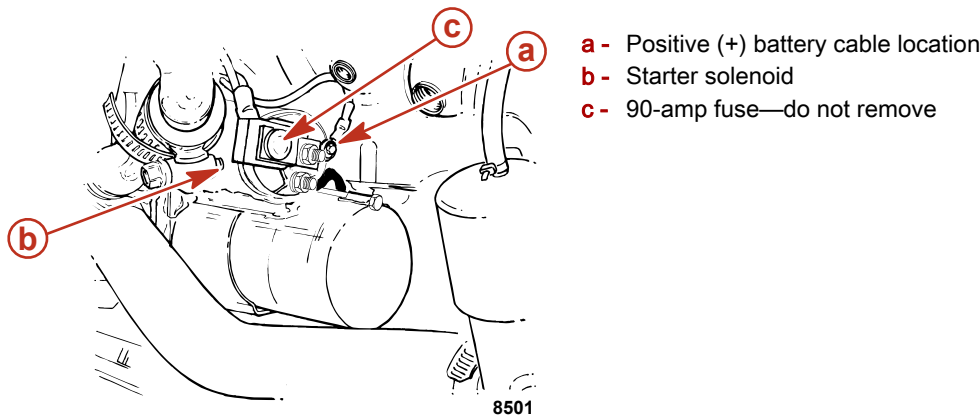
Description	Nm	lb-in.	lb-ft
Positive (+) battery cable nut (starter solenoid)	8–11	71–97	–

- c. Install the negative (–) battery cable to the ground stud on the flywheel housing and tighten securely.
 - d. After the battery cables are connected, apply a thin coat of Liquid Neoprene to the terminals.

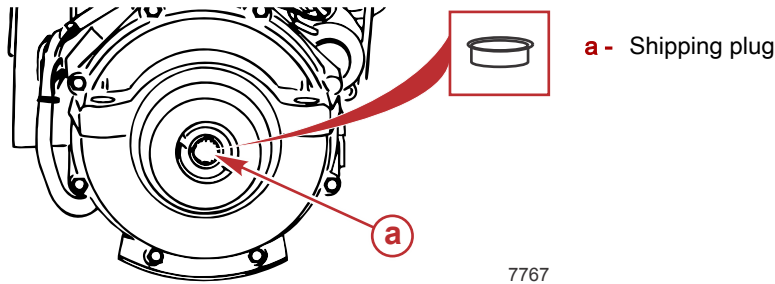
Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Battery terminals	92- 25711 3

- e. Slide the rubber boot over the positive (+) terminal after making the connection.
2. Temporarily lay the battery cables over the top of the engine to prevent interference during installation.

IMPORTANT: There is a fuse located at the starter solenoid. Do not remove this fuse.



3. If not already done, remove the shipping plug from the coupler and lubricate the splines with Extreme Grease.



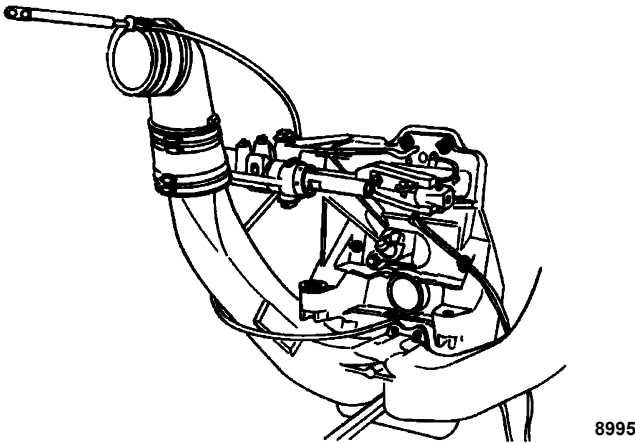
Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Coupler splines	8M0071842

Shift Cable Routing

Route the intermediate shift cable from the transom assembly to the shift actuator as follows:

- 1. The cable should come through the transom, above the exhaust pipe and turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing.
- 2. The cable should then be routed under the starboard rear engine mount and turn toward the transom.
- 3. The cable should then go up behind the power steering valve and loop over to the shift actuator on the engine.

NOTE: Following this routing will prevent the engine coupler from damaging the cable.

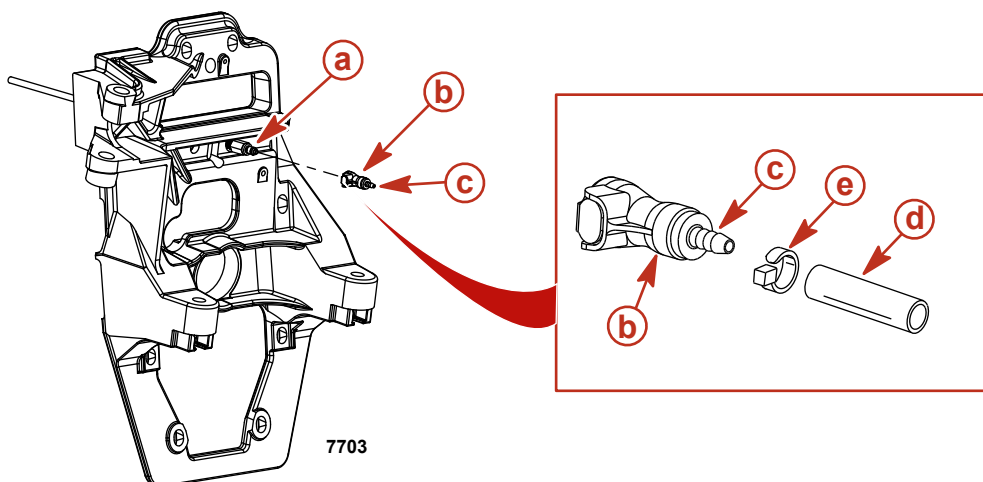


Connecting the Speedometer Pickup

IMPORTANT: Do not remove the plug from the speedometer pickup fitting unless you intend to make a connection to a speedometer pickup.

- 1. Remove the protective cap from the male quick connect.

2. Connect a 4 mm (5/32 in.) speedometer hose (not provided) from the speedometer to the barbed fitting. Secure the hose with a cable tie.



Typical

- a** - Male quick connect
- b** - Female quick connect
- c** - Barbed fitting
- d** - Hose
- e** - Cable tie

⚠ CAUTION

A ruptured speedometer hose can introduce water into the bilge, causing boat damage or possible sinking. Position or install the speedometer hose away from moving parts or pinch points, such as steering system components, engine coupler, or driveshaft, which could damage the hose.

3. Secure the hose to the transom with the hose clip and screw that are provided in the parts bag. Ensure that the hose does not contact the steering system components or the engine coupler and driveshaft.

Engine Installation and Alignment

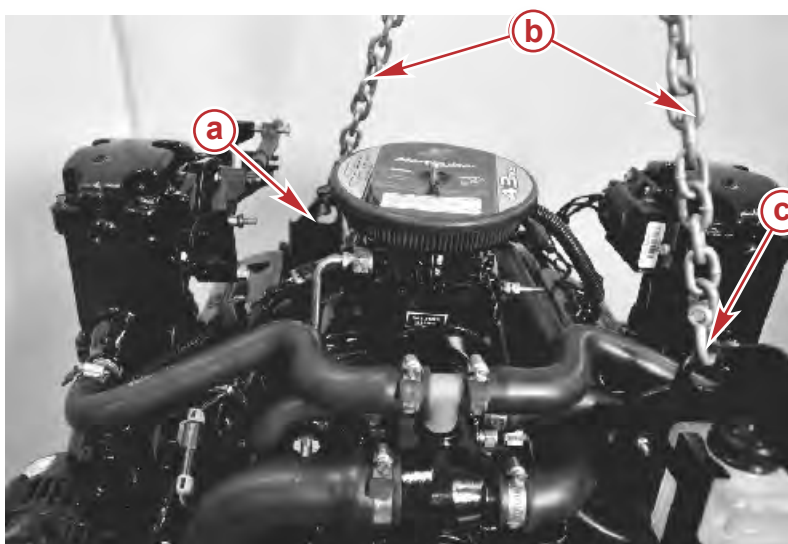
Installation

1. On engines where the engine mounts were disturbed, ensure that the front mount adjusting nuts are positioned midway on the studs so that adequate up and down adjustment exists for engine alignment.

⚠ CAUTION

Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

2. Attach a suitable sling and lifting arm (not shown) to the engine lifting eyes. Adjust the sling so that the engine is level when suspended.



TKS engine shown

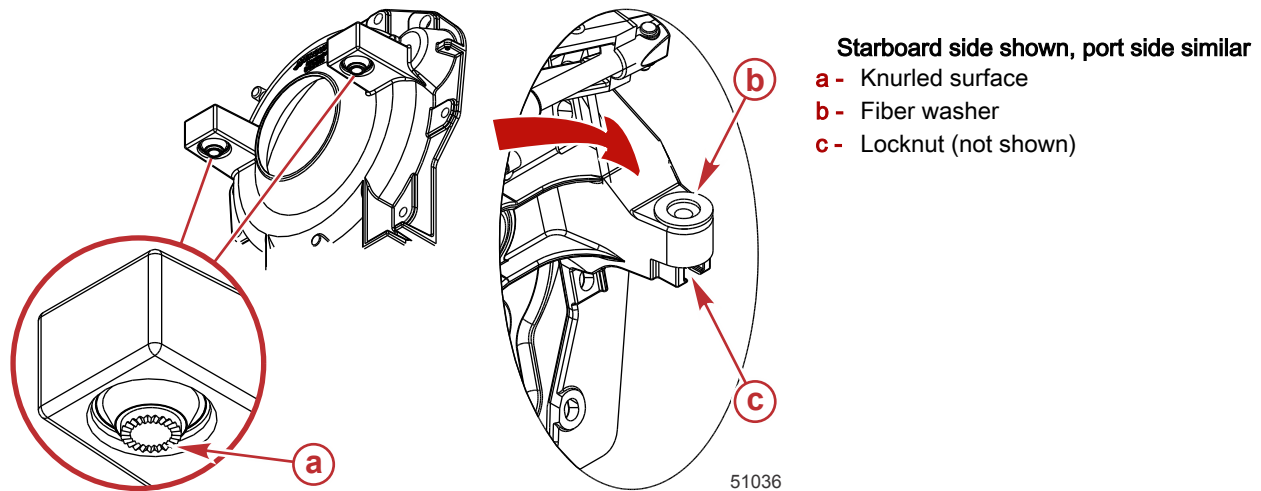
- a** - Rear lifting eye
- b** - Sling chains
- c** - Front lifting eye

53138

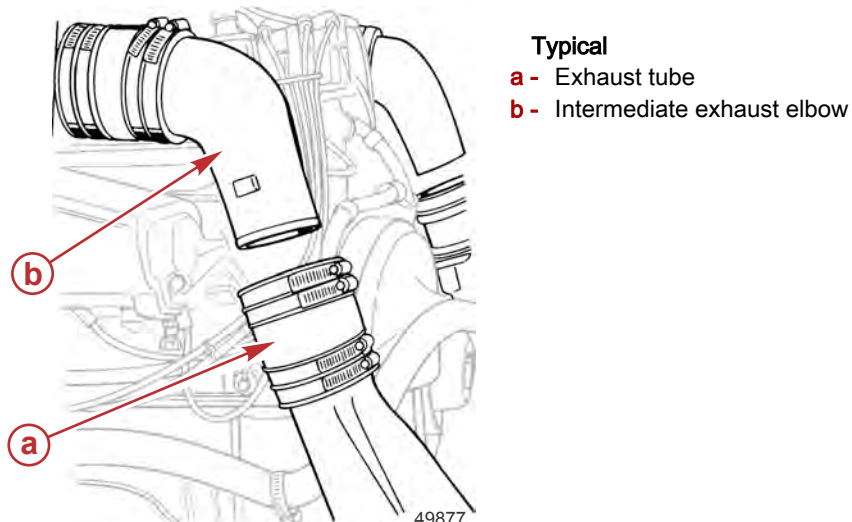
3. Lift the engine into position in the boat using an overhead hoist.
IMPORTANT: When lowering the engine into position do not set the engine on the shift cable.

IMPORTANT: If equipped with the Easy Engine Oil Drain system, the clearance for the drain fitting must be greater than 13 mm (½ in.) from the engine compartment and the boat bottom.

4. Ensure that the fiber washers and locknuts are on the inner transom plate mounts.

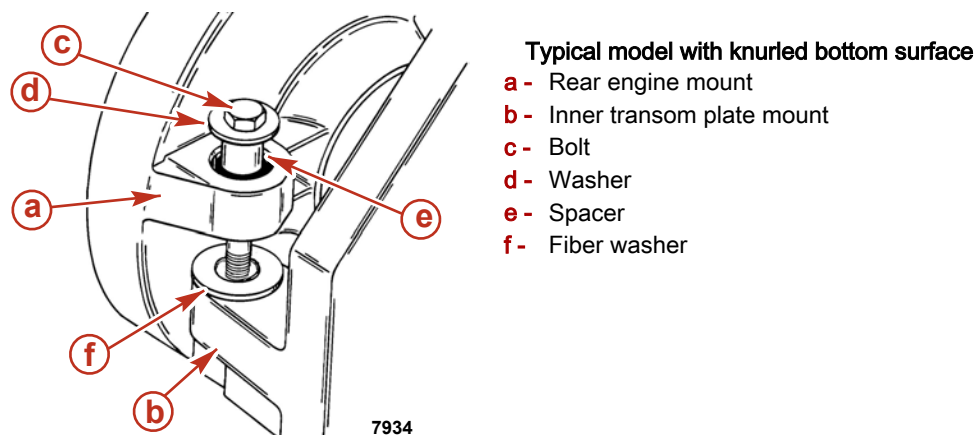


5. Align the intermediate exhaust elbows with the exhaust tubes.



IMPORTANT: Exhaust tubes must be secured at each connection with at least two hose clamps.

6. Lower the engine and align the rear engine mounts with the inner transom plate mounts. Ensure that the exhaust elbows slip into the exhaust tubes.
7. Set the engine onto the inner transom plate mounts. Do not relieve the hoist tension.
IMPORTANT: The engine mounting hardware must be installed in the order shown.
8. Install and tighten both rear engine mounting bolts to the specified torque with the hardware as shown.



Description	Nm	lb-in.	lb-ft
Rear engine mounting bolts	47	–	35

9. Adjust the front engine mounts until they rest on the boat stringers.
10. Relieve the hoist tension entirely and fasten both mounts to the boat stringer using the appropriate hardware.
11. Securely tighten all exhaust tube clamps to the specified torque.

Description	Nm	lb-in.	lb-ft
Tridon® hose clamp (exhaust tube)	4-4.7	35-42	–
Norma® hose clamp (exhaust tube)	2.9-3.4	26-30	–

12. Disconnect the sling from the engine lifting eyes.

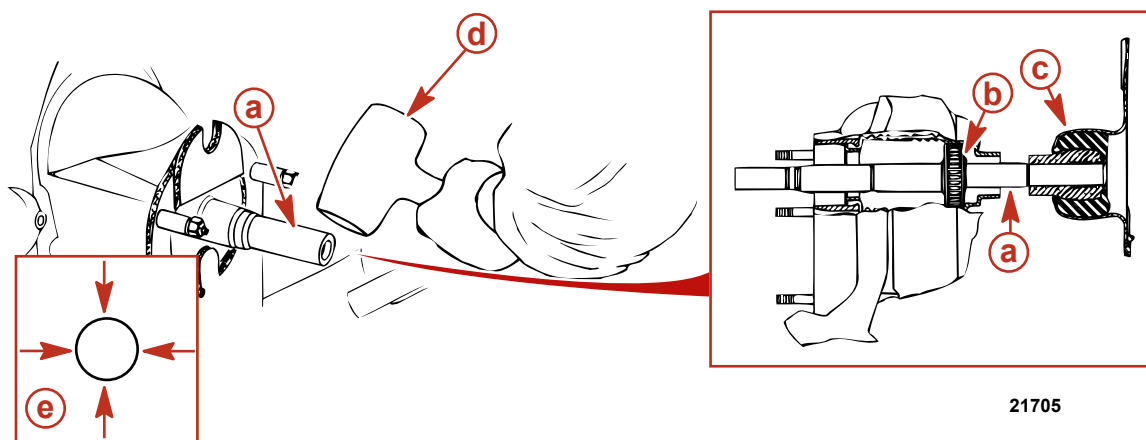
Alignment

IMPORTANT: Alignment tools from other manufacturers may cause improper alignment and damage to the gimbal bearing or engine coupler. Use only the Mercury alignment tool.

NOTICE

Improper use of the alignment tool may result in personal injury or damage to the gimbal bearing or engine coupler. Do not operate the engine with the alignment tool installed. Do not attempt to force the alignment tool, raise or lower the engine with the tool inserted in the gimbal bearing or engine coupler, or raise the engine mount bracket above the top of the engine mount stud.

1. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
2. If necessary, firmly strike the sides of the alignment tool with a synthane hammer at 90° increments to help align the gimbal bearing to the coupler.



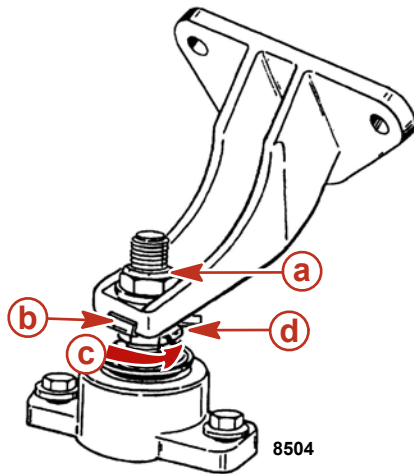
21705

- a** - Mercury alignment tool
- b** - Gimbal bearing
- c** - Engine coupler
- d** - Synthane hammer
- e** - 90° increments

Alignment Tool Assembly	91-805475A 1
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3. If the alignment tool does not fit, remove it and carefully adjust the front engine mounts:
IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in the direction required to align the engine.

- a. To adjust the engine up or down, loosen the locknuts on both front mounts. Turn the adjusting nuts as necessary.



Typical front mount

- a - Locknut
- b - Tab washer
- c - Direction (counterclockwise) to raise the front of the engine
- d - Adjusting nut

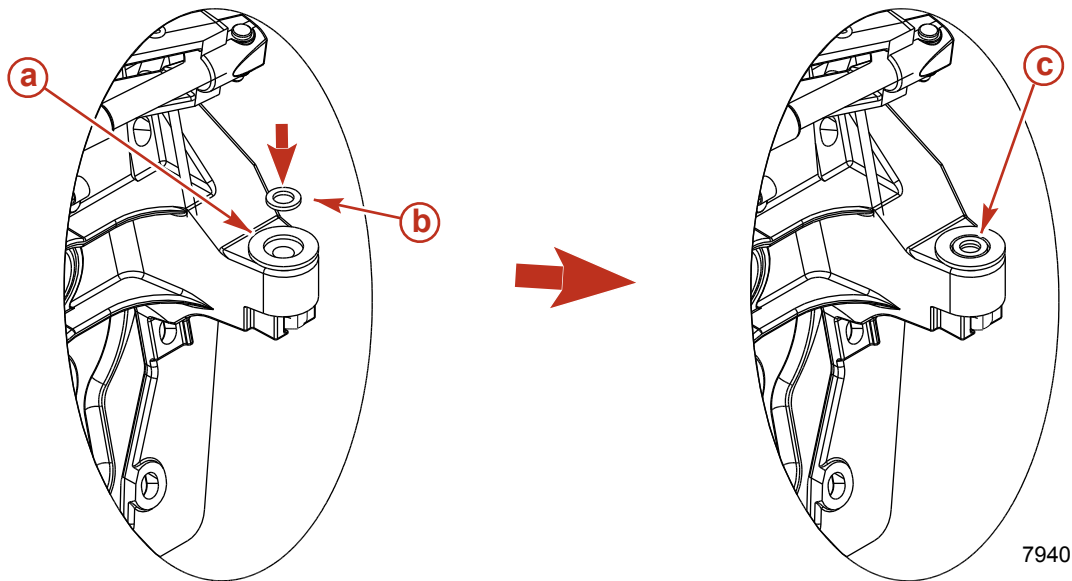
- b. Tighten the locknuts.

4. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.

NOTE: A spacer kit (12-892619A01) is available to raise the rear of the engine. This kit is only necessary if alignment cannot be obtained with the normal adjustment. If the front or side mounts are lowered fully and the front of the engine needs to be lowered more to obtain alignment, the spacer kit can be installed in the rear mount to raise the rear of the engine.

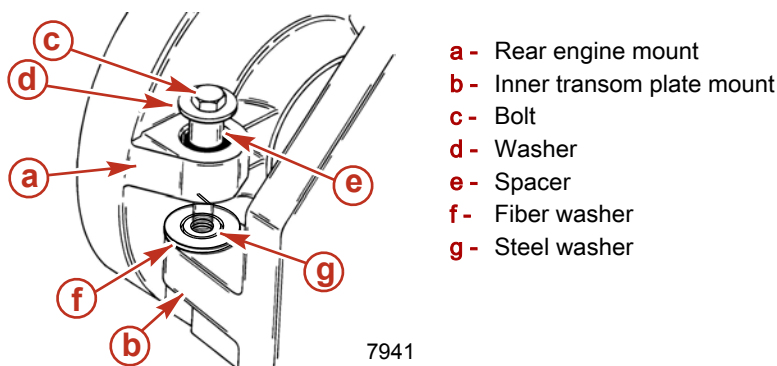
5. On models where the front engine mounts cannot be lowered enough to allow for proper engine alignment:
 - a. Attach a suitable sling and lifting arm to the engine lifting eyes and adjust so that the engine is level when suspended.
 - b. Remove the rear engine mounting bolts and hardware.
 - c. Using an overhead hoist, lift the engine enough to install a stainless steel washer inside the inner diameter of both fiber washers.

NOTE: This will position the washer between the new engine mount and the transom mounting support, raising the engine slightly for additional front mount adjustment.



- a - Fiber washer
- b - Steel washer
- c - Corrected mount area

- d. Install and tighten both rear engine mounting bolts to the specified torque with appropriate hardware, as shown.



Description	Nm	lb-in.	lb-ft
Rear engine mounting bolts	51	–	38

- e. Set the engine on the boat stringers.
 f. Relieve the hoist tension.
 g. Disconnect the sling from the engine lifting eyes.
- Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
 - Repeat the necessary steps until the alignment tool easily slides (freely with two fingers) all the way into and out of the engine coupler splines. Do not check by turning the alignment tool.
 - Fasten the front mount assemblies to the boat stringers using the appropriate hardware.
 - Tighten both front mount locking (jam) nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Front mount locking (jam) nuts	80	–	59

- Recheck the alignment with the alignment tool. The tool must enter the coupler splines freely. If not, remove the alignment tool and readjust the front mounts.
- Remove the alignment tool.
- If operating in a saltwater environment, apply Perfect Seal to the threads and nuts of the engine mounting hardware to help protect against corrosion. This will allow for easier loosening in the future, if readjustment becomes necessary.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Engine mounting hardware threads and nuts	92-34227Q02

Connecting the Fluid Systems

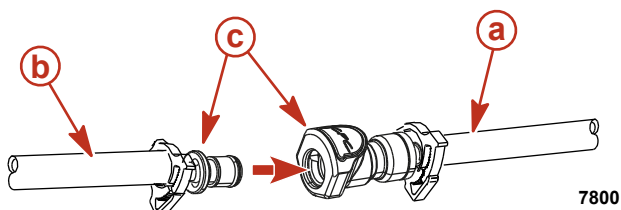
Gear Lube Monitor Connection

IMPORTANT: Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. Avoid kinks, and route the hose in a straight path to avoid low spots (traps) in the system.

- Position the gear lube monitor quick connect at the rear of the engine.
- Position the gear lube monitor quick connect at the transom.

IMPORTANT: The hose must not come in contact with the steering system components, engine coupler, U-joint shaft, or driveshaft.

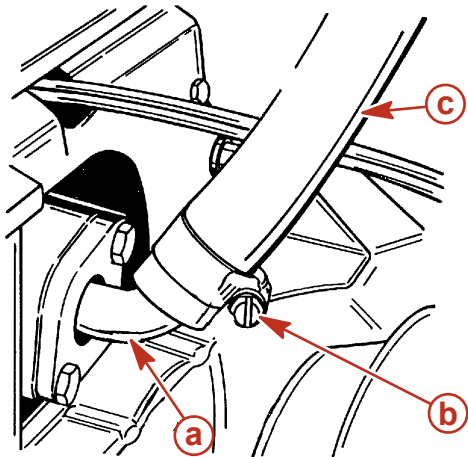
- Fasten the quick connect.



- a - Gear lube monitor hose assembly from transom
 b - Gear lube monitor hose assembly from gear lube monitor
 c - Quick-connect fitting

Alpha Seawater Inlet Hose Connection

1. Connect the seawater inlet hose to the water inlet fitting on the transom.



- a - Water inlet fitting
- b - Hose clamp
- c - Seawater inlet hose

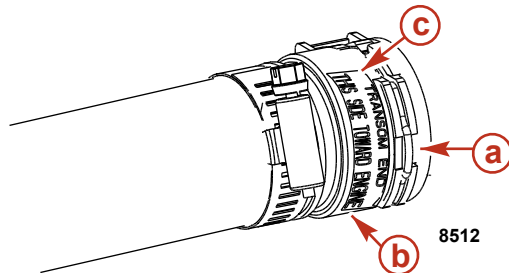
7802

2. Secure with a hose clamp.

Bravo Seawater Inlet Fitting Connection

NOTE: The retainer clip must be in the closed position prior to installation.

1. Connect the seawater inlet hose assembly to the water inlet fitting.
 - a. Position the retainer clip in the closed position.

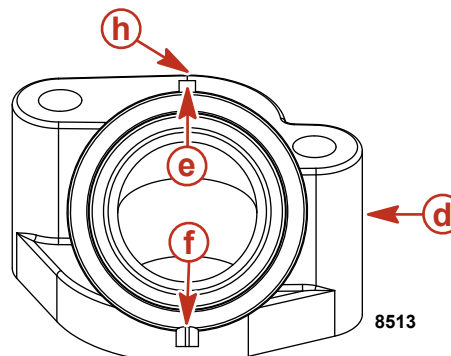
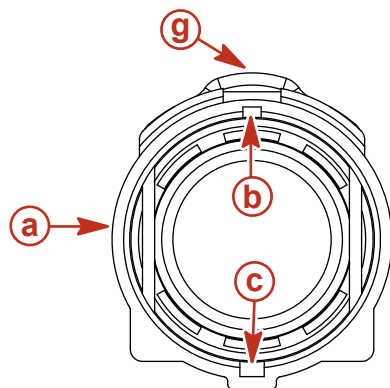


Seawater inlet hose assembly

- a - Retainer clip closed
- b - Quick-connect fitting
- c - Hose decal

8512

- Position the seawater inlet hose assembly with the center of the retainer clip and the hose decal toward the engine.
- IMPORTANT:** Tabs and slots are sized to mate only at the correct orientation. Mate the small tab with the small slot.
- Align the slots of the quick-connect fitting to the tabs of the seawater inlet fitting.

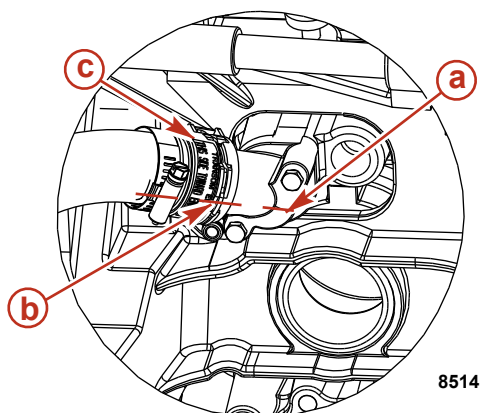


- a - Quick-connect fitting
- b - Small slot
- c - Large slot
- d - Seawater inlet fitting
- e - Small tab
- f - Large tab
- g - Center of retainer clip (toward engine)
- h - Centerline of water inlet fitting (toward engine)

8513

- Ensure that the centerline of the water inlet fitting and the center of the retainer clip are positioned toward the engine.
2. Push the seawater inlet hose assembly onto the water inlet fitting until they are connected.

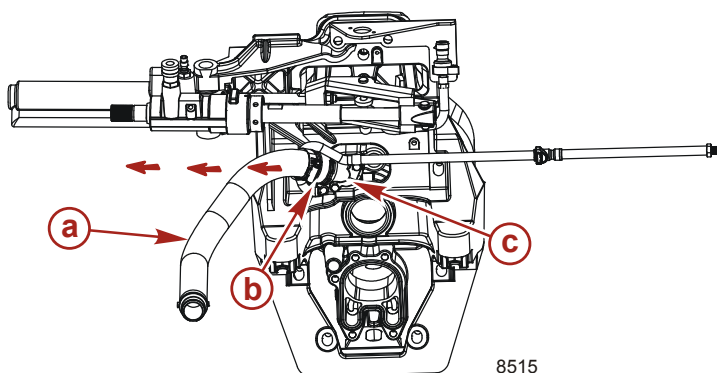
NOTE: The retainer clip snaps into place and assumes the closed position when properly connected.



Shown with engine removed for visual clarity

- a - Centerline of water inlet fitting
- b - Retainer clip in closed position
- c - Hose decal

3. Perform a pull test on the water hose quick connection.
 - a. Pull on the seawater inlet hose near the connection point with an approximate force of 111 N (25 lbf). If the seawater inlet hose does not become separated from the seawater inlet fitting when force is applied, the seawater inlet hose is connected and sealed properly.



Shown with engine removed for visual clarity

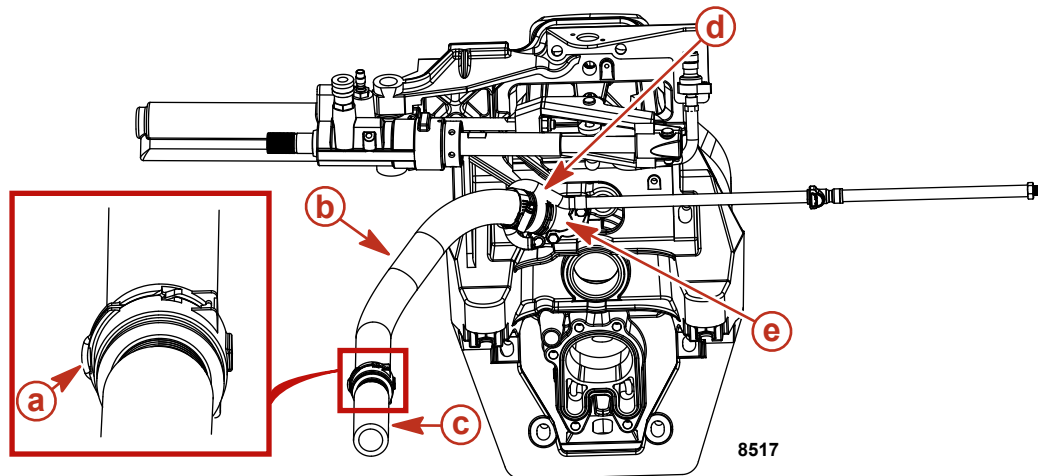
- a - Seawater inlet hose
- b - Quick-connect fitting
- c - Seawater inlet fitting

- b. If the seawater inlet hose does become separated from the seawater inlet fitting, reinstall as specified.
 - c. When all steps have been completed, check for any leaks at this connection.
4. Connect the seawater inlet hose to the engine seawater pump. Secure the connection with a hose clamp.
5. Models using the seawater extension hose assembly:

NOTE: The seawater inlet hose connects to the engine and the transom. The seawater extension hose assembly connects to the transom and the seawater inlet hose.

Installation

- a. When connecting the seawater extension hose assembly to the seawater inlet hose assembly, position the center of the retainer clip away from the engine.

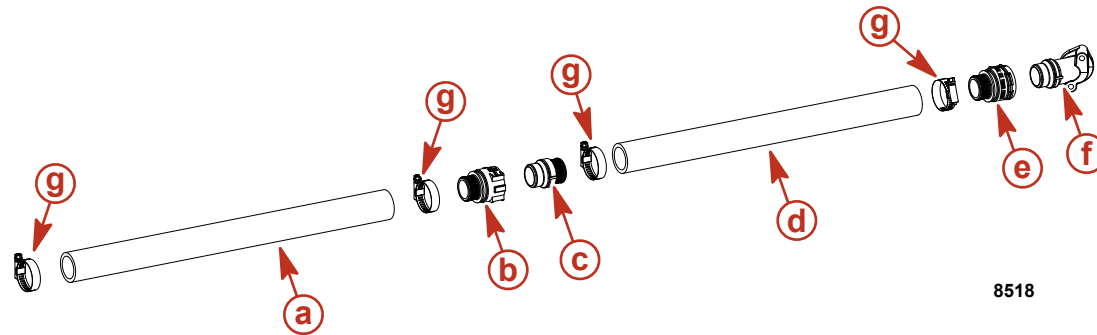


Shown with engine removed for visual clarity

- a - Retainer clip position (away from engine)
- b - Seawater extension hose
- c - Seawater inlet hose (to engine seawater pump)
- d - Quick-connect fitting (to seawater inlet fitting)
- e - Seawater inlet fitting (to transom)

- b. Perform a pull test at the seawater inlet connection to ensure that the seawater inlet hose is connected properly.

NOTE: The seawater extension hose assembly connects to the transom and the seawater inlet hose.



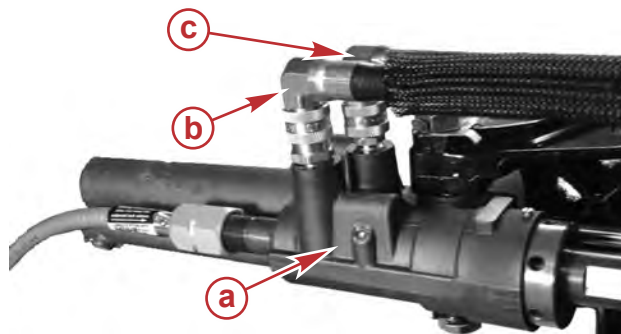
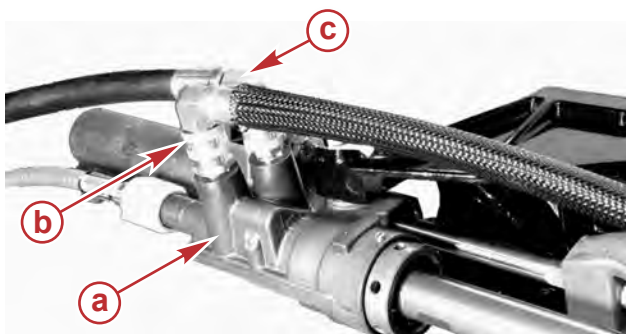
- a - Seawater inlet hose
- b - Quick-connect fitting to extension hose
- c - Quick-connect male fitting
- d - Extension hose
- e - Quick-connect fitting to seawater inlet fitting
- f - Seawater inlet fitting
- g - Hose clamp

Power-Assisted Steering Hoses

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaks.

1. Route the hoses to avoid contact with the steering system components.
2. If required, use extra hose clips to secure the hoses to the transom.

- On models with quick-connect fittings, connect the power-assisted steering hoses to the actuator. Ensure that the quick-connect fittings snap into place.



51039

- a - Power-assisted steering actuator
- b - High-pressure hydraulic supply hose
- c - Low-pressure hydraulic return hose

NOTE: Ensure that the steering fluid level is correct before first operation.

Speedometer and Pitot Connections

Refer to the appropriate sterndrive service manual for details on connecting the speedometer and pitot sensor.

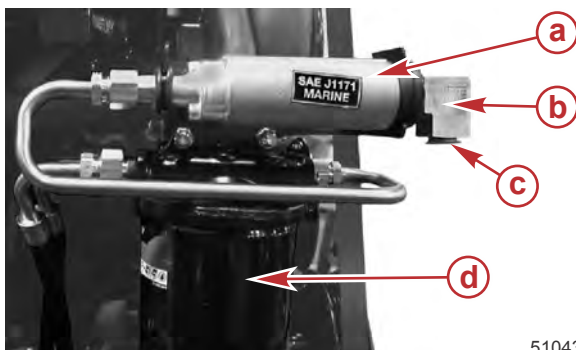
Gen II Cool Fuel Inlet Fitting

⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

NOTE: The standard configuration does not include a boost pump.

- If the fuel system is equipped with a boost pump, the fuel line connects to the barbed fitting on the fuel boost pump. Refer to the appropriate MerCruiser installation manual for additional details.



Typical fuel system boost pump

- a - Boost pump
- b - Fuel inlet fitting
- c - Barbed fitting (not shown)
- d - Water-separating fuel filter

51043

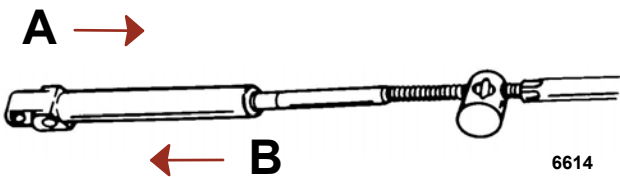
- If the fuel system is not equipped with a boost pump, the fuel line connects directly to the water-separating fuel filter.

Connecting the Alpha Shift Cable

Alpha Sterndrive Shift Cable Installation

IMPORTANT: Sterndrive unit propeller rotation is determined by the shift cable installation in the remote control.

- If the shift cable end guide moves in direction "A" when the control lever is placed in forward, the remote control is set up for right-hand (RH) propeller rotation.
- If the shift cable end guide moves in direction "B" when the control lever is placed in forward, the remote control is set up for left-hand (LH) propeller rotation.



Arrow indicates direction of motion

IMPORTANT: When installing shift cables, ensure that the cables are routed in such a way as to avoid sharp bends and contact with moving parts. Do not fasten any items to the shift cables.

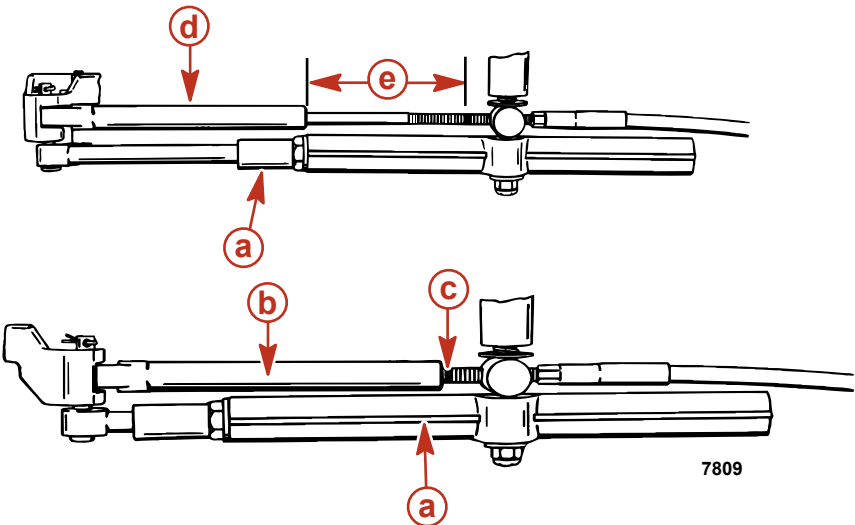
Shift Cable Travel

We recommend the use of a Mercury remote control and cable. Refer to **Mercury Precision Parts Accessories Guide** for selection. However, if a control other than Mercury is to be used, the control must provide the specified shift cable travel (at the shift plate end).

Description	Specification
Shift cable travel at the shift plate end	73–80 mm (2-7/8–3-1/8 in.)
NOTE: The specified travel is given as with a 6.8–9 kg (15–20 lb) load applied to the cable end guide.	

NOTE: On engines with Alpha drives, the measurement indicated above can be taken by installing the remote control shift cable and using the shift assist assembly (provided) to place the proper load on the shift cable.

1. Place the remote control shift handle into forward and mark the guide at the edge of the cable end guide. (Item "c" in the illustration below.)
2. Shift into reverse and measure the distance between the mark and the edge of the cable end guide. (Item "e" in the illustration below.)
 - If the measurement is outside of the range in the table shown above, refer to your remote control service manual for repair or replacement of the control. Measurements that are outside of this range will cause shift issues and possible safety concerns.
 - Measurements in the range listed are OK.

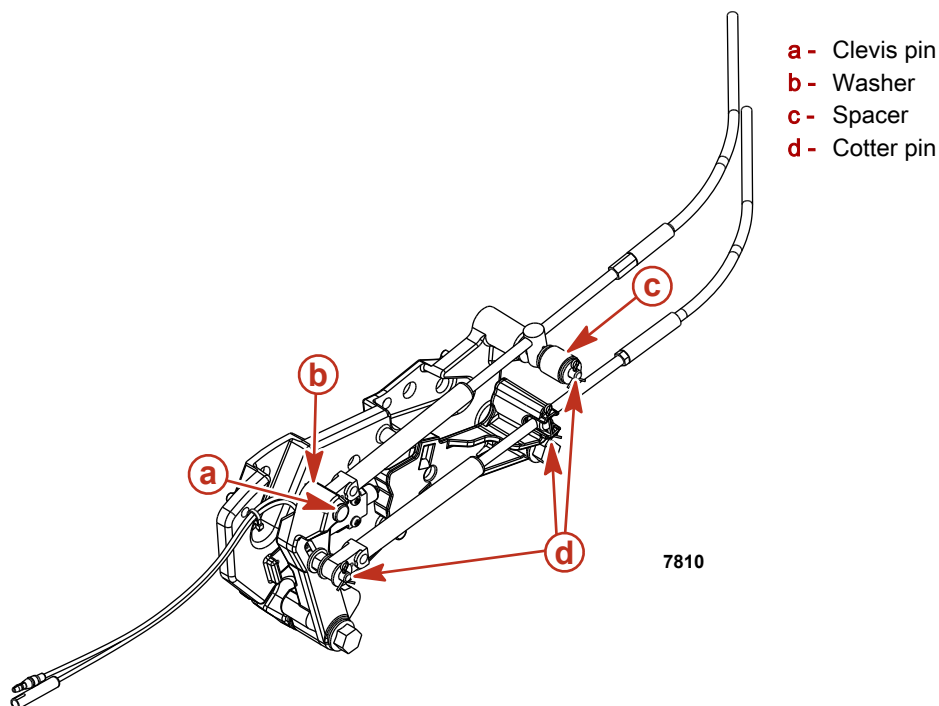


- a - Shift assist assembly
- b - Remote control shift cable, in forward gear position
- c - Edge of cable end guide
- d - Remote control shift cable, in reverse gear position
- e - Measurement taken from mark to edge of cable end guide

Separate Shift and Throttle Controls

IMPORTANT: If the boat is to be equipped with a remote control that has separate shift and throttle levers, the shift assist assembly that is shipped with the engine should not be used. The use of the shift assist assembly with this type of remote control can cause the shift lever to move out of gear unexpectedly.

A spacer kit (23-11284A1) is required to connect the remote control shift cable when the shift assist assembly is not used.

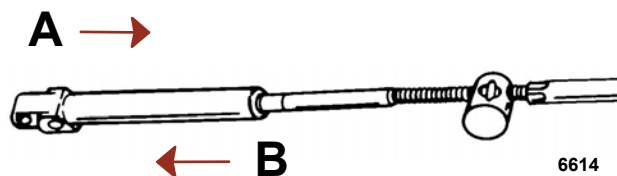


NOTE: Do not discard the shift assist assembly until after it is used as described in the following.

IMPORTANT: The shift cable must be connected at the remote control for the appropriate rotation (LH or RH) drive unit, as explained following:

Right-hand rotation: The control cable must be installed in the remote control so that the cable end will move in direction "A" when the shift handle is placed in the forward position.

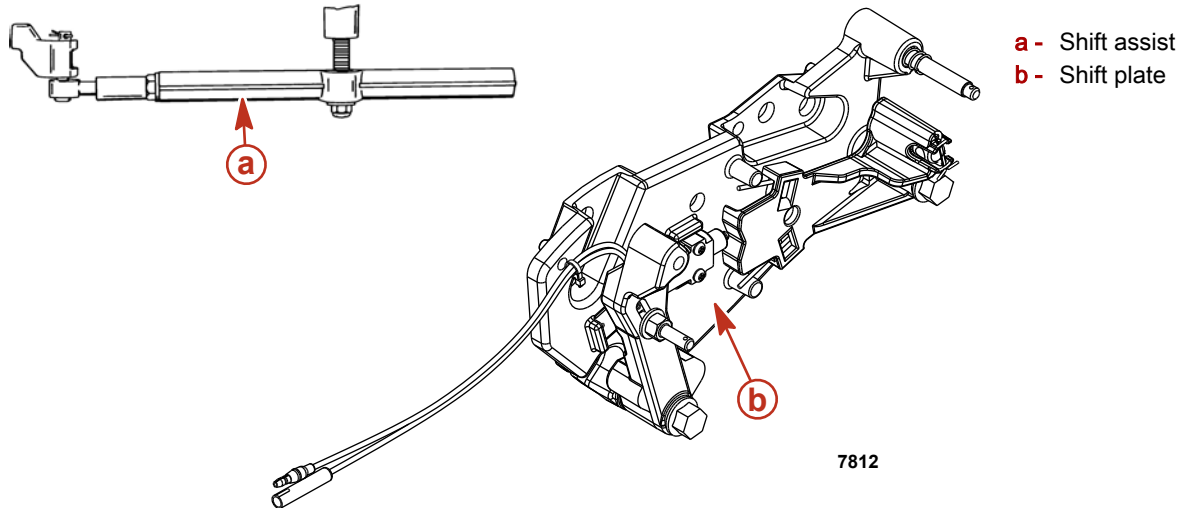
Left-hand rotation: The control cable must be installed in the remote control so that the cable end will move in direction "B" when the shift handle is placed in the forward position.



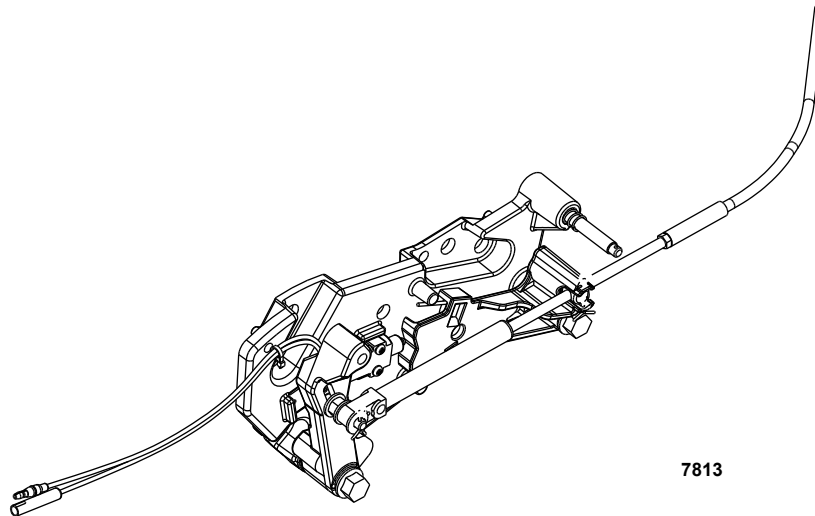
Installation

1. Remove the shift assist assembly.

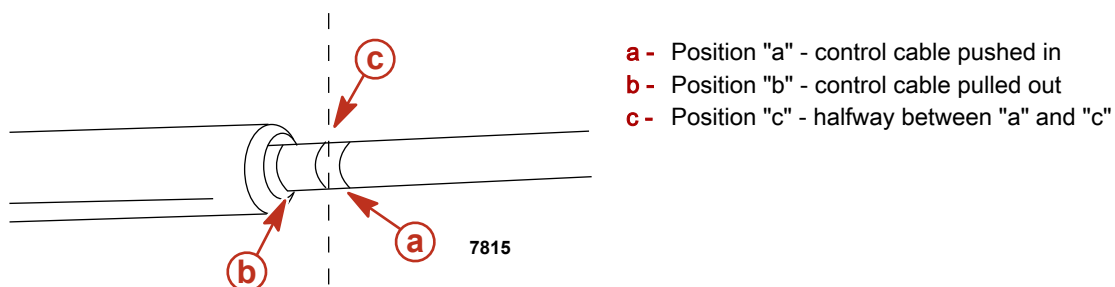
2. Remove the shift cable attaching hardware.



3. Install the intermediate cable.

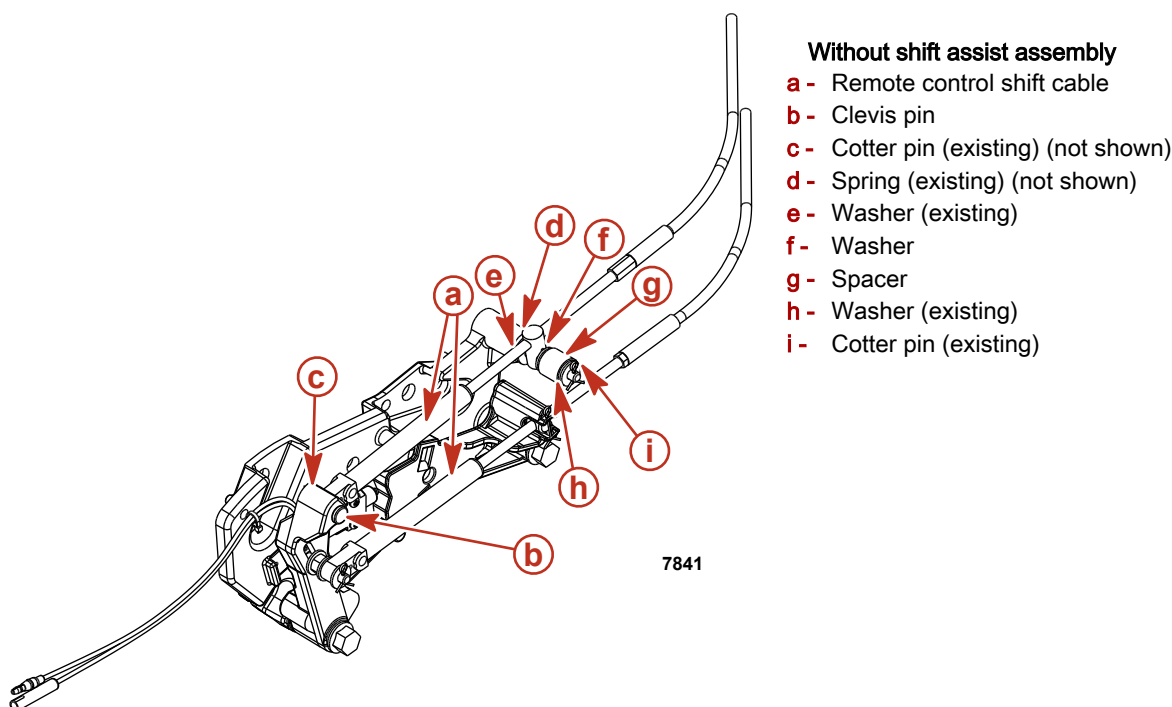
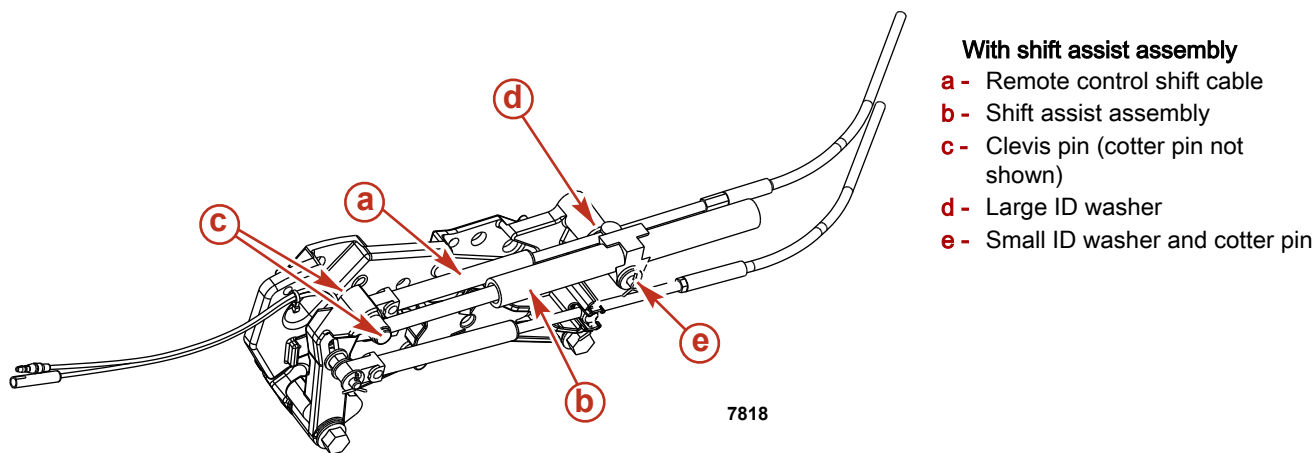


4. Secure the brass barrel retainer with the cotter pin.
5. Secure the cable end guide with washers (one on each end of the end guide) and the cotter pin.
6. Locate the center of the remote control cable play (backlash).
 - a. Shift the remote control to neutral.
 - b. Push in on the control cable end with enough pressure to remove play, and mark position "a" on the tube.
 - c. Pull out on the control cable end with enough pressure to remove play, and mark position "b" on the tube.
 - d. Measure the distance between marks "a" and "b," and mark position "c" halfway between marks "a" and "b."



7. Temporarily install the control cable end guide into the shift lever and insert the anchor pin.
IMPORTANT: Keep center mark "c" aligned with the control cable end guide edge when making the following adjustment.
8. Adjust the control cable barrel so that the hole in the barrel centers with the vertical centerline of the stud. Ensure that the backlash center mark is aligned with the edge of the control cable end guide.

9. Place the remote control and the sterndrive unit in forward gear.
10. Install the remote control shift cable.
11. Place the remote control handle in neutral.
12. Install the shift assist assembly. Ensure that it fits over the clevis pin and barrel stud with no resistance.
13. Install the fastening hardware. If the shift assist assembly attaching points will not align, verify that the controller is in neutral. Remove the shift cable and reposition the adjustment barrel as required to allow the shift assembly to be installed with no effort.



Connecting the Bravo Shift Cable

Bravo Models Shift Cable Installation

NOTE: Using the shift cable adjustment tool and the following procedure, shift cables can be adjusted with or without the sterndrive installed.

Shift Cable Adjustment Tool	91-12427T
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IMPORTANT: Sterndrive propeller rotation is determined by the shift cable installation in the remote control.

- Bravo One/Two: If the shift cable end guide moves in direction A when the control lever is placed in forward, the remote control is set up for right-hand (RH) propeller rotation.

Installation

- **Bravo One/Two:** If the shift cable end guide moves in direction B when the control lever is placed in forward, the remote control is set up for left-hand (LH) propeller rotation.



Arrow indicates direction of motion

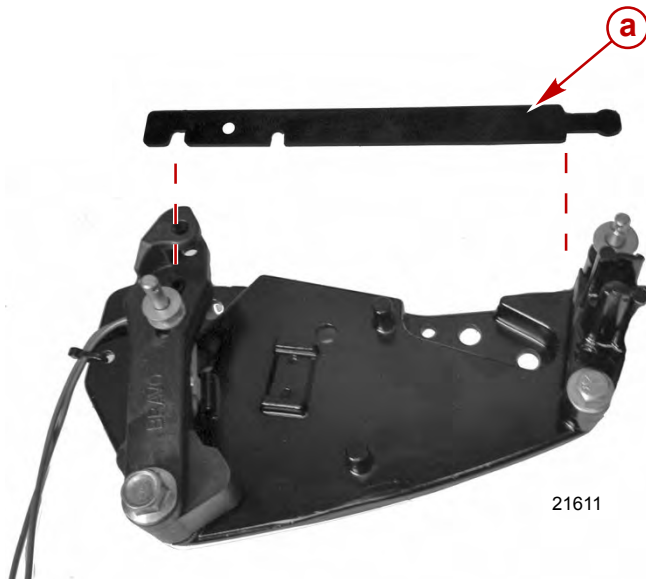
- **Bravo Three:** The front propeller on a Bravo Three sterndrive is always LH rotation and the rear propeller is always RH rotation. The shift cable end guide must move in direction A when the control lever is placed in the forward gear position.



IMPORTANT: When installing shift cables, ensure that the cables are routed in such a way as to avoid sharp bends and contact with moving parts. Do not fasten any items to the shift cables.

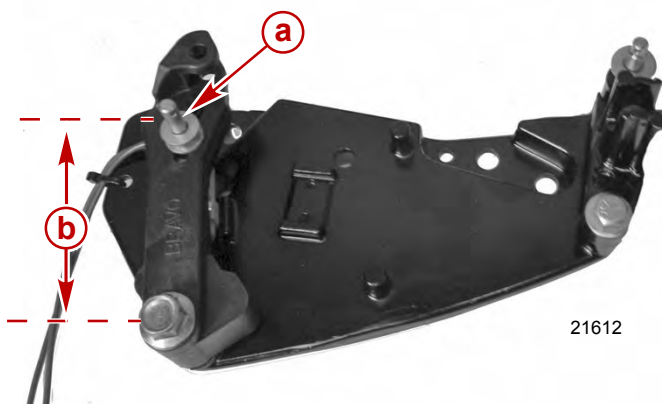
Bravo Models Shift Cable Adjustment

1. Remove the adjustment tool.



a - Adjustment tool

2. Loosen the adjustable stud and move it so that dimension "b" (shown below) is 76 mm (3 in.). Retighten the stud.

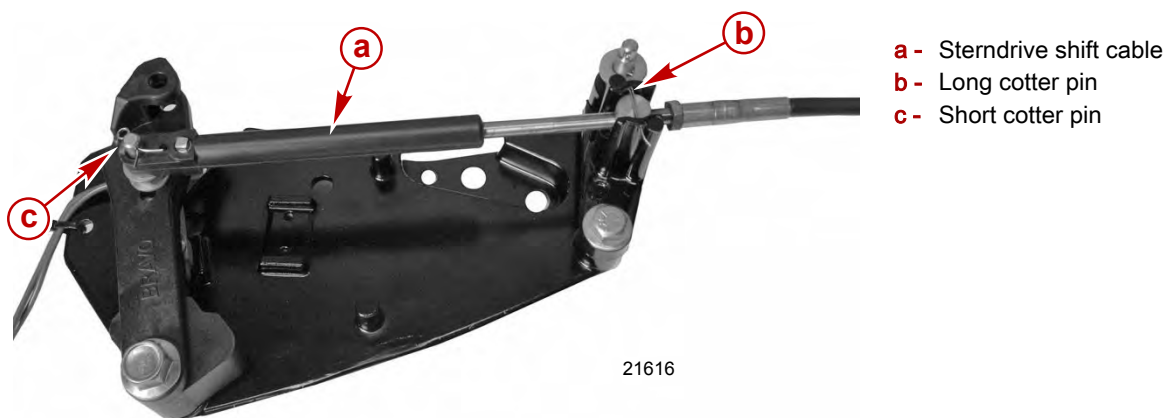


a - Adjustable stud

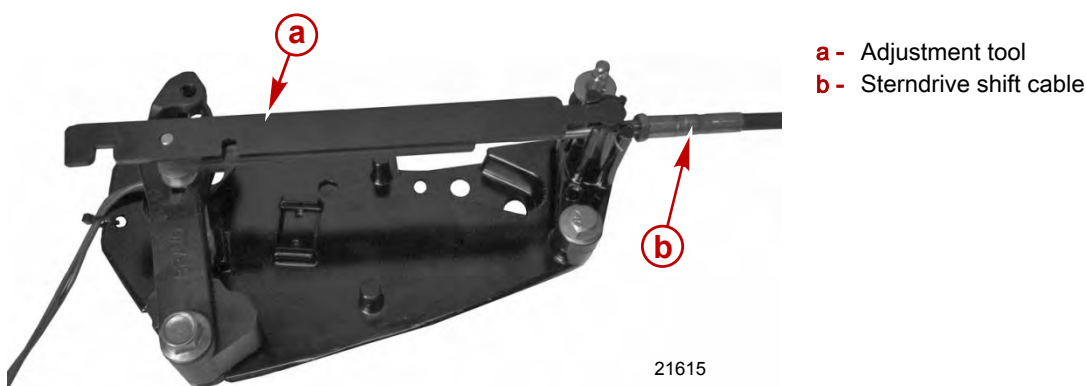
b - 76 mm (3 in.) (center of pivot bolt to center of stud)

3. Install the sterndrive shift cable.
4. Install the long cotter pin from the top and spread the ends fully.

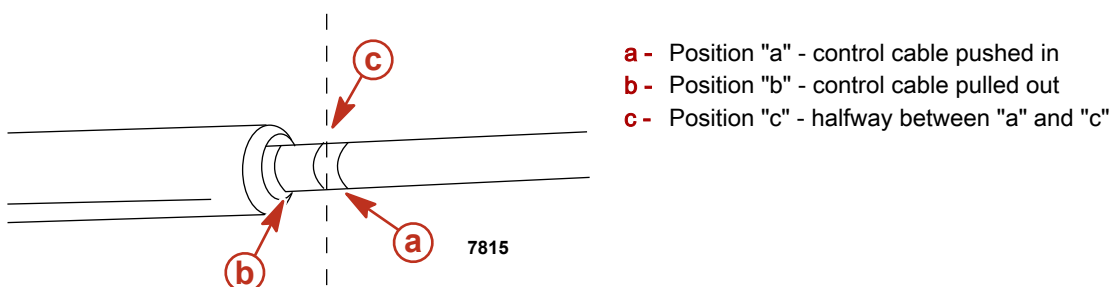
5. Insert the short cotter pin from the top and spread the ends fully.



6. Place the adjustment tool over the sterndrive shift cable, as shown. Hold the tool in place using a piece of tape over the barrel retainer.

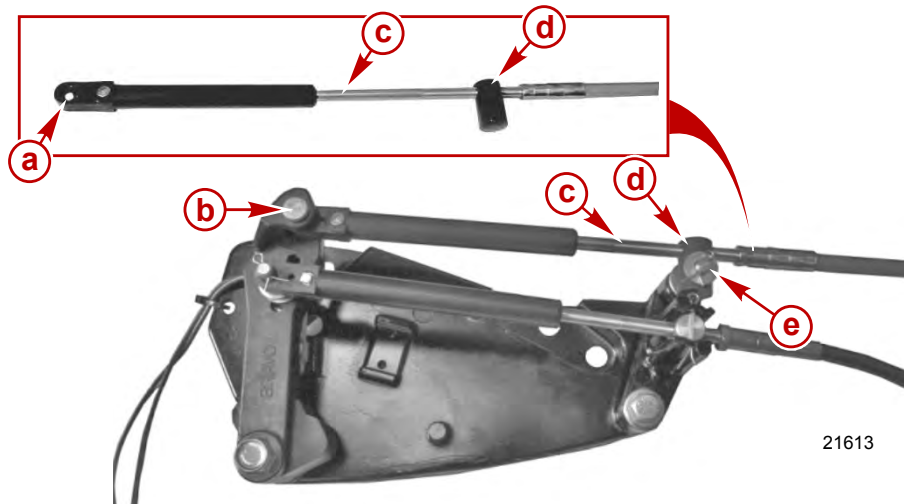


7. Locate the center of the remote control cable play (backlash).
 - a. Shift the remote control to neutral.
 - b. Push in on the control cable end with enough pressure to remove play, and mark position "a" on the tube.
 - c. Pull out on the control cable end with enough pressure to remove play, and mark position "b" on the tube.
 - d. Measure the distance between marks "a" and "b," and mark position "c" halfway between marks "a" and "b."



8. Temporarily install the control cable end guide into the shift lever and insert the anchor pin.
IMPORTANT: Keep center mark "c" aligned with the control cable end guide edge when making the following adjustment.
9. Adjust the control cable barrel so that the hole in the barrel centers with the vertical centerline of the stud. Ensure that the backlash center mark is aligned with the edge of the control cable end guide.

10. Remove the control cable end guide from the shift lever by removing the clevis pin.



- a - Control cable end guide
- b - Clevis pin
- c - Backlash center
- d - Control cable barrel
- e - Stud, washer, and cotter pin

11. Install the control cable.
12. Install the washer and cotter pin to secure the barrel.
13. Install the clevis pin.
14. Install the cotter pin into the clevis pin from the top and spread the ends.
15. Remove the adjustment tool.
16. Shift the remote control lever into the forward position. Place the end of the adjustment tool in the barrel retainer. If the slot does not fit over the stud, loosen the shift lever stud and slide the stud up or down until the slot in the tool fits over the stud. When the adjustment is correct, retighten the stud.
17. Lift the adjustment tool so that the slot is above the stud.
18. Shift the remote control into reverse and repeat the adjustment process.



- a - RH-rotation Bravo One, Two, and Three forward slot; LH-rotation Bravo One and Two reverse slot
- b - LH-rotation Bravo One and Two forward slot; RH-rotation Bravo One, Two, and Three reverse slot

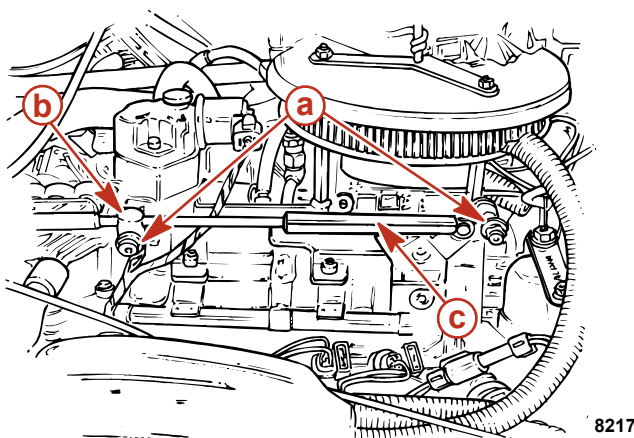
19. Remove the adjustment tool.
20. Ensure that all cotter pins are secure and that the ends of the cotter pins are spread to 180°.
21. Lubricate the shift cable pivot points with clean engine oil.

Throttle Cable Installation and Adjustment

IMPORTANT: When installing throttle cables, ensure that the cables are routed to avoid sharp bends and to avoid contact with moving parts. Do not fasten any items to throttle cables.

1. Place the remote throttle lever in the idle position and attach the cable to the throttle body, following the cable manufacturer's instructions.
2. Install the cable end guide onto the throttle lever, then push the cable barrel end lightly toward the throttle lever end. (This will place a slight preload on the shift cable to avoid slack in the cable when moving the remote control lever.)
3. Adjust the barrel on the throttle cable to align with the hole in the anchor plate. Ensure that the hole in the barrel positions the cable as shown.

4. Tighten the locknut until it contacts the washer, and then loosen it 1/2 turn.



- a** - Locknut and flatwasher
b - Cable barrel
c - Cable end

Connecting the Electrical Components

Electrical Connections

IMPORTANT: Refer to the following precautions when working on or around the electrical harness, or when adding other electrical accessories, to avoid damage to the electrical system.

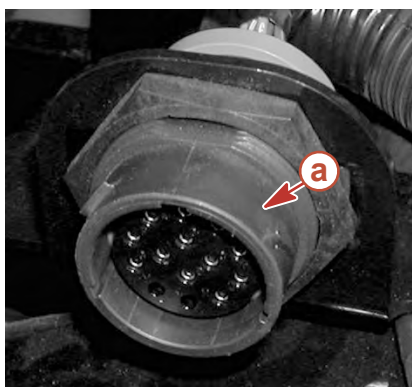
- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

IMPORTANT: When routing all wire harnesses and hoses, ensure that they are routed and secured to avoid coming in contact with hot spots on engine and to avoid contact with moving parts.

Tube Ref No.	Description	Where Used	Part No.
 25 	Liquid Neoprene	All electrical connections	92- 25711 3

Engine Harness Connections

1. Route the instrumentation wiring harness back to the engine, making sure that the harness does not rub or get pinched. If an extension harness is required, ensure that the connection is properly secured.
2. Fasten the harnesses to the boat at least every 46 cm (18 in.) using the appropriate fasteners.
3. Connect the instrumentation wiring harness to the engine harness connector. Turn the locking ring until it firmly snaps.



23135



23136

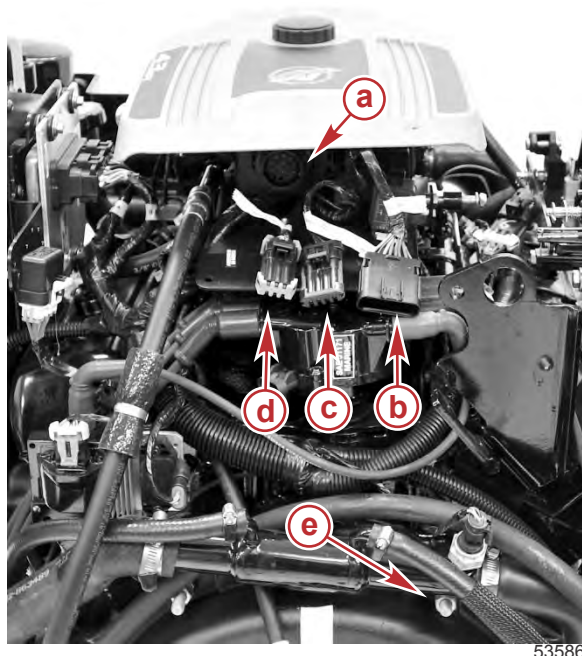
Typical

a - Engine harness connector

4. Connect the transom harness 16-pin connector.
5. If equipped, connect the depth transducer to the data link connector (DLC) on the engine harness.
6. If equipped, connect the paddle wheel and tank level connector.

Installation

7. Connect any grounding wires and accessories that were disconnected from the engine during the removal process.

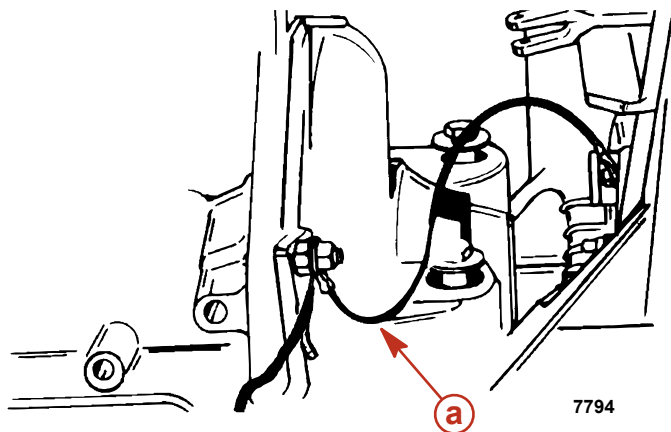


- a** - 14-pin connector
- b** - 16-pin transom harness connector
- c** - DLC connector
- d** - Paddle wheel and tank level connector
- e** - Grounding stud

Continuity Wire Connection

Connect the continuity circuit wire from the engine to the transom assembly.

IMPORTANT: Do not attach any accessory ground (-) wires to the transom plate ground point. Accessory ground wires must only be attached to the ground stud on the engine.



- a** - Continuity wire

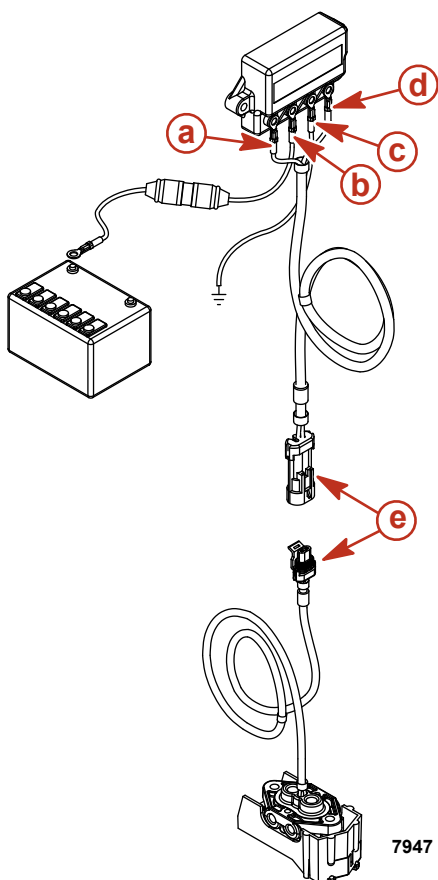
Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

MerCathode System

1. Connect the wires to the MerCathode controller assembly, if they are not already connected. Connect the male and female quick-connect terminals.

NOTE: Some models are equipped with a 5-amp spade fuse in the red/purple wire (to the positive [+] battery terminal).



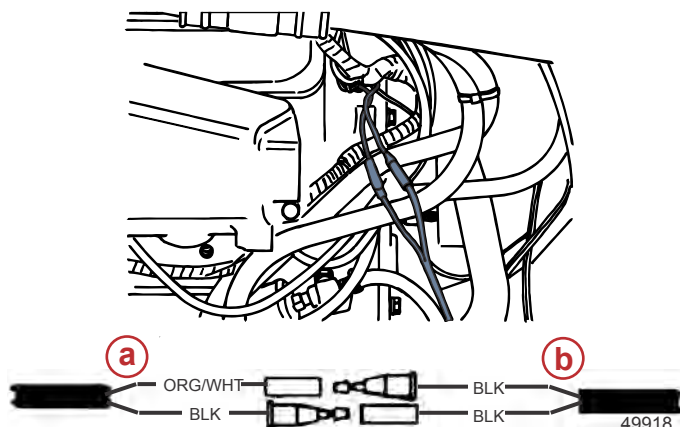
- a -** Orange lead—from anode on transom assembly (through the quick-connect fitting)
- b -** Red/purple wire—to positive (+) battery terminal
- c -** Black wire—from engine harness, if equipped, or to negative (–) battery terminal
- d -** Brown wire—from electrode on transom assembly (through the quick-connect fitting)
- e -** Male and female quick-connect terminals

2. Apply a thin coat of liquid neoprene to all wire connections.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Exposed terminals and connections	92- 25711 3

Trim Position Sender Connections

Connect the trim position sender wires from the transom assembly to the engine harness. Use the orange/gray wire for analog gauges and the orange/white wire for digital gauges.



Digital gauge connection shown, analog similar

- a -** Engine harness bullet connectors
- b -** Transom assembly bullet connectors

Installing the Sterndrive Unit

Refer to the appropriate Mercury MerCruiser sterndrive service manual for procedures related to the installation of the sterndrive unit.

Battery Connection

IMPORTANT: The sterndrive must be installed before connecting the battery. Refer to the appropriate Mercury MerCruiser sterndrive service manual.

1. Ensure that the power trim pump, the MerCathode controller, and the accessory wiring (if equipped) are properly connected to the battery terminals.
2. Connect the battery cables to the battery by first connecting the positive (+) battery cable (usually red) to the positive (+) battery terminal. Tighten the clamp securely.
3. Connect the negative (–) battery cable (usually black) to the negative (–) battery terminal. Tighten the clamp securely.
4. Ensure that all of the battery terminal connections are tight. Spray the terminals with a battery connection sealant to help retard corrosion.

Tube Ref No.	Description	Where Used	Part No.
	Battery connection sealant	Battery terminal connections	Obtain Locally

5. Apply sealant to the exposed terminals and electrical connections.

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Exposed terminals and connections	92- 25711 3

Troubleshooting Shift Problems

If hard shifting, chucking, or ratcheting is encountered when shifting into forward gear, refer to the remote control manual or to the appropriate sterndrive service manual for troubleshooting information.

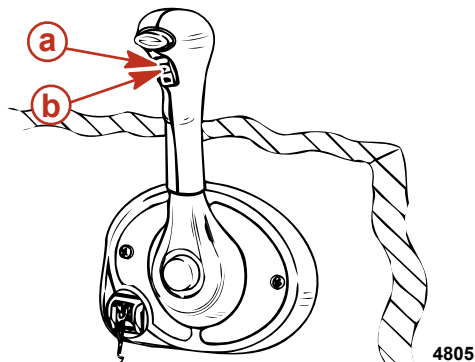
Bravo Sterndrive Shift Check (Engine Running)

The following procedure is performed with the boat out of the water and the engine running.

WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. Use the sterndrive tilt switch on the remote control handle to lower the sterndrive to the down/in position. Do not allow the sterndrive skeg to contact the ground.



Typical single handle remote control shown

- a -** Drive trim switch
b - Drive trailer button

2. Connect a water hose between the flushing attachment and a water source.

Dual Water Pick-up Flush Seal Kit	91-881150K 1
Flushing Attachment	91-44357Q 2
Flushing Kit	91-849996T 1

3. Partially open the water source until water continuously flows out around the flushing attachment.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: Engines with the sterndrive water inlet blocked off at the gimbal housing and using a through-the-hull water inlet need a supply of cooling water available to both the sterndrive and the engine during operation.

4. Place the remote control handle in neutral, idle speed position and start the engine.

NOTE: The sterndrive is shifting properly when the sterndrive shifts with minimal effort in and out of each gear (forward, neutral, and reverse) at idle speed position.

NOTE: The operator at the remote control handle should feel a slight detent before and after each gear: forward, detent, neutral, detent, reverse.

IMPORTANT: The sterndrive is not shifting properly if the sterndrive shifts after the engine throttle is advanced.

5. Move the remote control handle to the forward, idle speed position.
6. Check that the sterndrive propeller shaft is turning in the forward direction.
7. Shift the remote control handle to the neutral, idle speed position.
8. Check that the sterndrive propeller shaft is not turning.
9. Shift the remote control handle to the reverse, idle speed position.
10. Check that the sterndrive propeller shaft is turning in the reverse direction.
11. If the sterndrive will not shift:
 - a. Remove the sterndrive and check the shift linkage assembly and shift cable.
 - b. Check the shift cable installation and adjustment. Refer to the Bravo sterndrive service manual for detailed instructions.

IMPORTANT: Be sure that the shift cables are routed in such a way as to avoid sharp bends and contact with moving parts. Do not fasten any items to the shift cables.

Flame Arrestor and Engine Cover

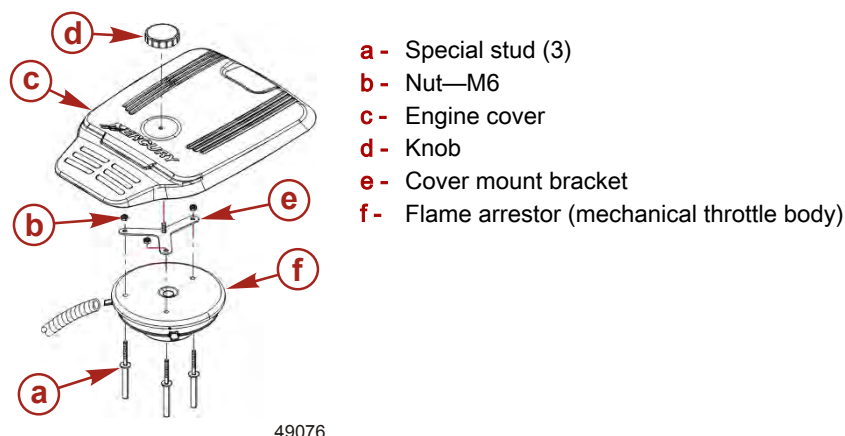
Installation

Models with a Mechanical Throttle Body

1. Install the flame arrestor with the cover mount bracket on the three special studs. Ensure that the "FRONT" mark is oriented to the pulley end of the engine.
2. Install the three M6 nuts. Tighten the nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
M6 flame arrestor nut	2.8	25	–

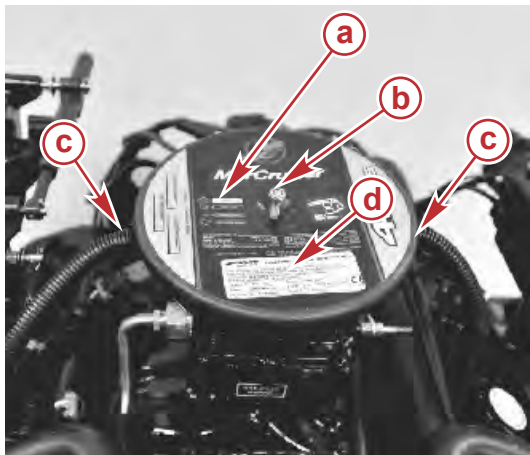
3. Install and connect the crankcase ventilation hose to the flame arrestor and rocker arm cover fittings.
4. Install the engine cover. Securely tighten the knob.



Models with a TKS Carburetor

1. Install the flame arrestor on the stud. Ensure that the emission label is oriented to the front of the engine.

2. Install the washer and 1/4-20 nut. Tighten the nut to the specified torque.



- a - Flame arrestor
- b - 1/4-20 nut and washer
- c - Crankcase ventilation hoses
- d - Emission label

53130

Description	Nm	lb-in.	lb-ft
1/4-20 flame arrestor nut	3	28	–

3. Connect the crankcase ventilation hose to the flame arrestor and rocker arm cover fittings.

Engine

Section 3A - Engine Mechanical

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Engine Mechanical

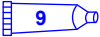
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General Specifications

4.3 Liter (262 cid)

Description		Specification
Bore		101.60 mm (4.012 in.)
Stroke		88.39 mm (3.480 in.)
Firing order		1-6-5-4-3-2
Compression ratio		9.2:1
Heads		Cast iron
Intake manifold - Two piece	Upper	Aluminum
	Lower	Cast iron
Intake manifold (carbureted)		Cast iron
Block		Cast iron
Rods		Powder metal or forged steel
Crankshaft		Cast iron
Pistons		Cast aluminum
Camshaft		Steel

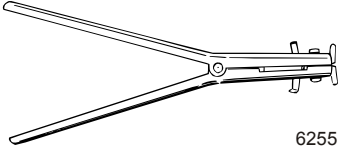
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Expansion cup plug (camshaft rear bearing hole)	Obtain Locally
	Needle Bearing Assembly Lubricant	Valve stem locks	8M0071836
	Loctite 567 PST Pipe Sealant	End of new suction pipe	92-809822
	Loctite 242 Threadlocker	Intake manifold bolts	92-809821
		Balance shaft driven gear screw threads	
		Camshaft thrust plate retainer bolt threads	
		Outside diameter of engine block core hole expansion plug	
		Outside diameter of camshaft rear bearing hole expansion cup plug	
	MerCruiser 4-Cycle 25W-40 Engine Oil	Rocker arm	92-858048K01

Tube Ref No.	Description	Where Used	Part No.
	SAE Engine Oil 30W	Outside surface of valve stem bore and all surfaces of valve stem oil seal	Obtain Locally
		Valve pushrods and rocker arm assemblies	
		Balance shaft bearings	
		Balance shaft front bearing	
		Camshaft journals	
		Valve stem	
		Outside surface of valve stem bore and all surfaces of the valve stem oil seal	
		Oil pump components	
		Surfaces of oil pump gears and shafts	
		Seal surface of the crankshaft balancer	
		Rubber sealing surface	
		Front cover crankshaft seal	
		Cylinder walls	
		Connecting rod bearings, pistons, rings, and cylinder walls	
		Threads and mating faces of connecting rod cap and screws	
		Cylinder bores and other machined surfaces	
		Upper and lower bearing	
		Main bearings and crankshaft bearing journals	
		Connecting rod bearing surfaces	
		The seal to retainer mating surfaces, the seal lip, the flywheel pilot flange, and the flywheel locating pin	
		Block adapter O-rings	
	Premium Gear Lubricant	Valve pushrods, rocker arm and rocker arm ball contact surfaces	92-858058K01
	Loctite 5900 Ultra Black RTV Silicone Sealant	Lower intake manifold gaskets	92-809826
		Engine block at the lower intake manifold sealing surfaces	
		Crankshaft balancer keyway	
	Lubriplate SPO 255	Crankshaft front cover mating surface	Obtain Locally
		Camshaft lobes and valve lifters	
		Valve lifters	

Special Tools

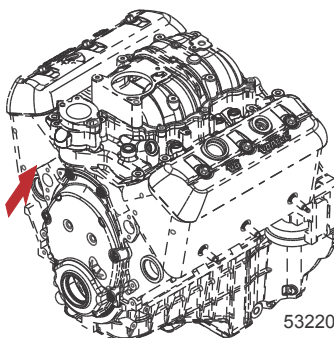
Ball socket adapter tool	J8520-1
	Ball socket adapter tool

Piston Ring Expander	91-24697
	Expands piston rings for removal and installation.

Identification

The Mercury MerCruiser model can be determined by looking at the last 2 or 3 letters of the engine code stamped into the engine block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement engine block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.



Engine code stamp

Sterndrive (MCM)	Code
4.3 Liter MPI Alpha and Bravo	4LJ, 5LJ, 6LJ, 7LJ, 8LJ, 9LJ, AD0, ADT AZT, B27, CG8
4.3 Liter TKS	4LB, 5LB, 6LB, 7LB, 8LB, 9LB, AD4, ADX, AZL, AZR, B28, CGA

Engine Specifications—4.3 Liter (262 cid)

Cylinder Head

Description		4.3 Liter (262 cid)
Surface flatness	At exhaust manifold deck	0.05 mm (0.0020 in.)
	At engine block deck with an 152 mm (6.0 in.) area	0.10 mm (0.0039 in.)
	At intake manifold deck	0.10 mm (0.0039 in.)
	Intake manifold flatness	0.10 mm (0.0039 in.)

Cylinder Bore

Description		4.3 Liter (262 cid)
Diameter		101.618–101.643 mm (4.0007–4.0017 in.)
Out of round	Production	0.0127 mm (0.0005 in.) maximum
	Service	0.05 mm (0.0020 in.)
Taper	Production—thrust side	0.012 mm (0.0005 in.) maximum
	Production—relief side	0.025 mm (0.0010 in.) maximum
	Service	0.025 mm (0.0010 in.) over production

Oil Pump

Description	Height
Oil pump dowel pin	6.4 mm (0.2520 in.)

Piston Bore Clearance

Description	4.3 Liter (262 cid)
Production	0.018–0.061 mm (0.0007–0.0024 in.)
Service	0.075 mm (0.0029 in.) maximum

Piston Rings

Top Compression

Description		4.3 Liter (262 cid)
Groove clearance	Production	0.030–0.070 mm (0.0012–0.0028 in.)
	Service	0.030–0.085 mm (0.0012–0.0033 in.)
Gap	Production	0.25–0.40 mm (0.010–0.016 in.)
	Service	0.45–0.66 mm (0.018–0.026 in.)

Second Compression

Description		4.3 Liter (262 cid)
Groove clearance	Production	0.040–0.080 mm (0.0015–0.0031 in.)
	Service	0.030–0.085 mm (0.0012–0.0033 in.)
Gap	Production	0.38–0.58 mm (0.015–0.023 in.)
	Service	0.38–0.80 mm (0.015–0.031 in.)

Oil Control

Description		4.3 Liter (262 cid)
Groove clearance	Production	0.046–0.196 mm (0.0018–0.0077 in.)
	Service	0.046–0.200 mm (0.0018–0.0079 in.)
Gap	Production	0.25–0.74 mm (0.010–0.029 in.)
	Service	0.005–0.090 mm (0.0002–0.0035 in.)

Piston Pin

Description		4.3 Liter (262 cid)
Diameter		23.545–23.548 mm (0.9270–0.9271 in.)
Clearance	Production	0.013–0.023 mm (0.0005–0.0009 in.)
	Service Limit	0.25 mm (0.010 in.) maximum
Fit in connecting rod		0.012–0.048 mm (0.0005–0.0019 in.) interference

Crankshaft

Main Bearing Journal

Description		4.3 Liter (262 cid)
Diameter	Number 1	62.199–62.217 mm (2.4488–2.4495 in.)
	Number 2, 3	62.191–62.215 mm (2.4485–2.4494 in.)
	Number 4	62.179–62.203 mm (2.4480–2.4489 in.)
Taper	Production	0.007 mm (0.0003 in.) maximum
Out of round	Production	0.005 mm (0.0002 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

Main Bearing Clearance

Description		4.3 Liter (262 cid)
Production	Number 1	0.018–0.053 mm (0.0007–0.0021 in.)
	Number 2, 3, 4	0.028–0.058 mm (0.0011–0.0023 in.)
Service	Number 1	0.025–0.050 mm (0.0010–0.0020 in.)
	Number 2, 3, 4	0.025–0.063 mm (0.0010–0.0025 in.)

Connecting Rod Journal

Description		4.3 Liter (262 cid)
Diameter		57.116–57.148 mm (2.2487–2.2497 in.)
Taper	Production	0.00508 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.007 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

Miscellaneous

Description	4.3 Liter (262 cid)
Runout	0.25 mm (0.010 in.) maximum
End play (thrust clearance)	0.05–0.20 mm (0.002–0.008 in.)

Connecting Rod

Connecting Rod Bearing

Description		4.3 Liter (262 cid)
Clearance	Production	0.038–0.078 mm (0.0015–0.0031 in.)
	Service Limit	0.025–0.063 mm (0.0010–0.0025 in.)
Rod side clearance		0.15–0.44 mm (0.006–0.017 in.)

Valve

Clearance (Lash)

Description	4.3 Liter (262 cid)
Intake and exhaust	Net lash No adjustment

Lifter

Description		4.3 Liter (262 cid)
Type		Hydraulic roller
Rocker arm ratio		1.50:1
Valve lift	Intake	10.527 mm (0.4140 in.)
	Exhaust	10.879 mm (0.4280 in.)

Head and Stem

Description		4.3 Liter (262 cid)
Valve diameter	Intake	46.74 mm (1.84 in.)
	Exhaust	38.1 mm (1.50 in.)
Face angle	Intake	45 degrees
	Exhaust	45 degrees
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum
Production stem diameter	Intake	8.661–8.679 mm (0.3410–0.3417 in.)
	Exhaust	
Service stem oversize diameter	Exhaust only	+0.774 mm (+0.0305 in.)
Valve stem oil seal	Installed height <i>NOTE: Measured from the top of the valve guide bevel to the bottom of the oil stem seal.</i>	1–2 mm (0.0394–0.0787 in.)

Stem Clearance

Description		4.3 Liter (262 cid)
Production	Intake	0.025–0.069 mm (0.0010–0.0027 in.)
	Exhaust	0.025–0.069 mm (0.0010–0.0027 in.)
Service	Intake	0.025–0.094 mm (0.0010–0.0037 in.)
	Exhaust	0.025–0.094 mm (0.0010–0.0037 in.)

Seat

Description		4.3 Liter (262 cid)
Seat angle	Intake and exhaust	46 degrees
Top correction cut angle		30 degrees
Bottom correction cut angle		60 degrees
Width	Intake	1.016–1.651 mm (0.040–0.065 in.)
	Exhaust	1.65–2.489 mm (0.0650–0.0980 in.)
Runout	Intake and exhaust	0.05 mm (0.0020 in.) maximum

Spring

Description		4.3 Liter (262 cid)
Free length		51.3 mm (2.02 in.)
Pressure	Valve closed	338–374 N (76–84 lb) at 43.2 mm (1.7008 in.)
	Valve open	832–903 N (187–203 lb) at 32.3 mm (1.2717 in.)
Installed height	Intake	42.92–43.43 mm (1.6898–1.7098 in.)
	Exhaust	
Approximate number of coils		4

Camshaft

Description		4.3 Liter (262 cid)
Journal diameter		47.440–47.490 mm (1.8677–1.8697 in.)
Journal out of round		0.025 mm (0.0010 in.) maximum
Camshaft runout		0.065 mm (0.0026 in.) maximum
Lobe lift	Intake	7.18–7.30 mm (0.283–0.287 in.)
	Exhaust	6.97–7.07 mm (0.274–0.278 in.)
End play		0.0254–0.2285 mm (0.0010–0.0090 in.)

Timing Chain

Description	4.3 Liter (262 cid)
Chain deflection	11 mm (0.4331 in.) maximum

Flywheel

Description	4.3 Liter (262 cid)
Runout	0.203 mm (0.0080 in.) maximum

Leak Down Testing

Possible Cause	Test Result
Leaking intake valve	Air is heard leaking up through the intake manifold at the throttle body or carburetor.
Leaking exhaust valve	Air is heard leaking into the exhaust system.
Leaking piston or piston rings	A high volume of air leaks into the test cylinder's rocker arm cover and can be felt flowing out of the oil fill or breather cap (low volume air bleed past the rings is normal).

Compression Test

Compression Test Diagnosis	
Minimum compression	690 kPa (100 psi)
Compression difference (The lowest compression cylinder should be no less than 70% of the highest compression cylinder.)	70%

SPX Corporation (Kent-Moore)

The tools listed below are some of those available from SPX Corporation. Equivalent tools may be available from other tool manufacturers. Regardless of supplier, always use the correct tool for the task at hand.

IMPORTANT: Part numbers are subject to change. Verify the correct tool part number with SPX Corporation.

SPX Corporation, Kent-Moore
28635 Mound Road
Warren, MI 48092-3499
1-800-345-2233

gmspecialservicetools.spx.com

Description	Part Number
Valve spring compressor (cylinder head on the engine)	J5892-D
Valve spring compressor (cylinder head off the engine)	J8062
Valve spring compressor (for testing)	J9666
Valve guide cleaner	J8101
Valve stem seal installer	J42073
Rocker arm stud remover	J5715

Description	Part Number
Rocker arm stud installer	J6880
Stud reamer (0.382 in.)	J6036
Carbon removing brush	J8089
Piston pin press	J24086-C
Piston ring groove cleaner	J3936-03
Piston ring compressor	J8037
Screw guide set	J5239
Oil suction pipe installer	J21882
Camshaft bearing remover and installer	J6098-01
Camshaft bearing remover and installer adapter	J6098-10
Crankcase balancer remover and installer	J23523-F
Front cover aligner and seal installer	J35468
Crankshaft gear puller	J5825-A
Spark plug port adapter	J23590
Main bearing shell remover	J8080
Rear main seal installer	J35621-B
Fuel line disconnect tool	J44581
Cylinder hone (kit)	J5902-01

Precautions

WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

CAUTION

Using compressed air can cause serious injury. Always wear eye protection when working with compressed air to prevent injury from ruptured hoses or flying debris.

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

NOTICE

Water trapped in the seawater section of the cooling system can cause corrosion or freeze damage. Drain the seawater section of the cooling system immediately after operation or before any length of storage in freezing temperatures. If the boat is in the water, keep the seacock closed until restarting the engine to prevent water from flowing back into the cooling system. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged.

IMPORTANT: Lubricate all moving engine components with clean engine oil or other specified lubricant during assembly.

Torque Specifications

External Engine Components

Description		Nm	lb-in.	lb-ft
Alternator brace to alternator bolt		28	–	21
Alternator brace to engine bolt		41	–	30
Alternator to mounting bracket bolt		48	–	35
Alternator mounting bracket bolt		41	–	30
Block adapter fitting or bushing		31	–	23
By-pass valve block adapter bolt		27	–	20
Coupler to flywheel bolts (MCM)		48	–	35
Engine coolant temperature (ECT) sensor		20	177	–
Engine mount, front bracket		41	–	30
Exhaust manifold screws	First pass	27	–	20
	Second pass	41	–	30
	Final pass	54	–	40
Fitting/bushing		50	–	37
Fuel rail bracket bolt		6	53	–
Fuel rail retainer nut		3	27	–
Ignition coil bolt		12	106	–
Knock sensor		20	–	15
MAPT sensor bolt		12	106	–
Oil pressure switch fitting		15	133	–
Seawater pump bracket		41	–	30
Starter motor bolt		50	–	37
Throttle body fasteners	Nut	10	89	–
	Stud	9	80	–
Water temperature sender		27	–	20

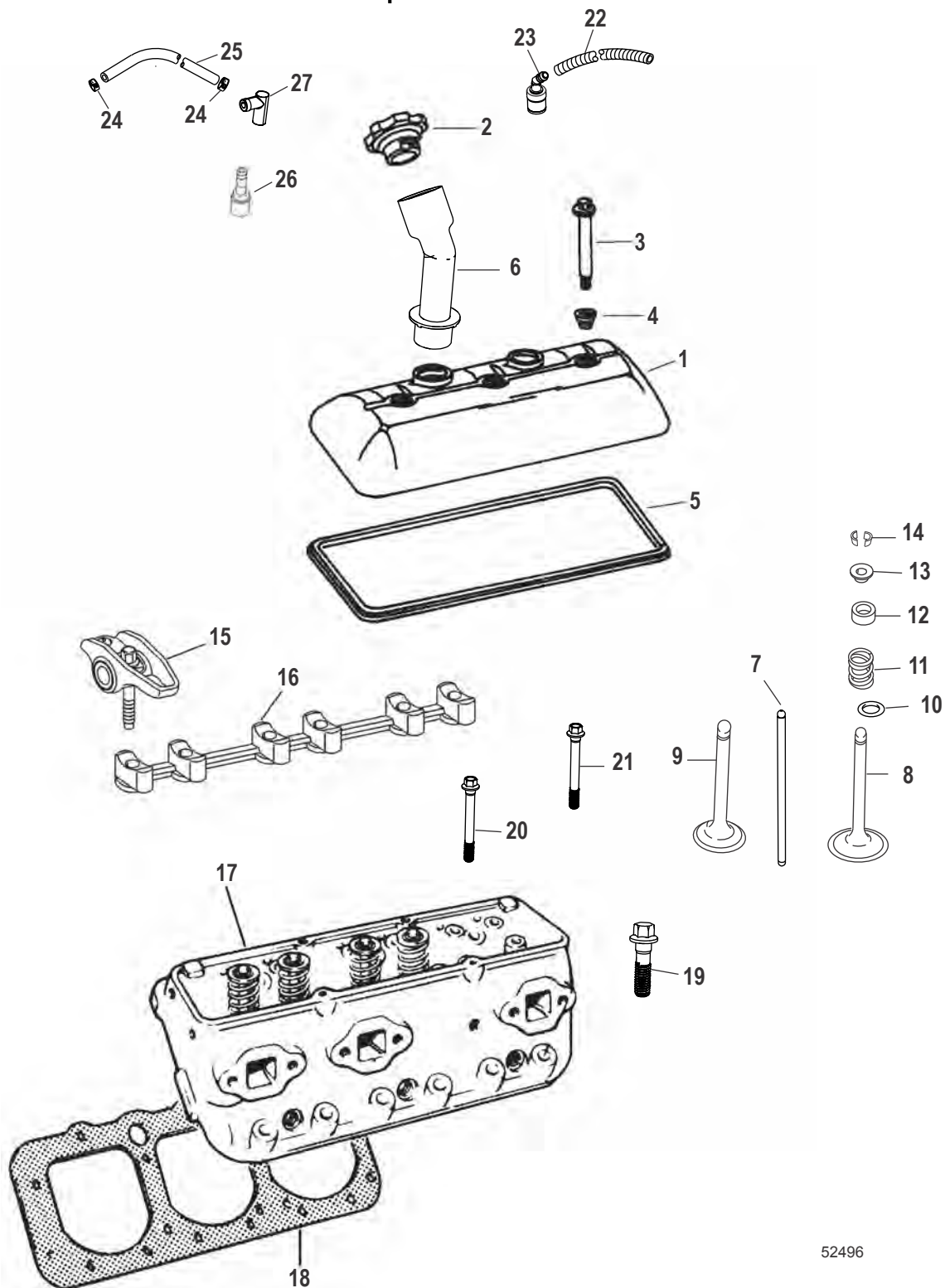
Description			Nm	lb-in.	lb-ft
Cylinder head screw (optional method)	All screws in sequence: long, medium, then short	First pass	35	–	26
		Second pass	60	–	44
		Final pass	90	–	66
Engine flywheel bolt			100	–	74
Engine block coolant drain hole plug			20	–	15
Flywheel housing studs and bolts			41	–	30
Flywheel housing cover			9	80	–
Oil lines			27	–	20

Description		Nm	lb-in.	lb-ft
Oil pan fitting hollow bolt		20	177	–
Oil pan drain plug		25	–	18
Oil pressure switch fitting		15	133	–
Oil pump cover bolt		12	106	–
Remote oil connector		34	–	25
Remote oil filter adapter nut/fitting		27	–	20
Thermostat housing bolt		41	–	30
Throttle body	Nut	10	89	–
	Stud	9	80	–
Water circulating pump bolt		45	–	33
Water pump pulley bolt		25	–	18

Notes:

Engine Components

Cylinder Head and Rocker Cover Components S/N 0M322781 and Above

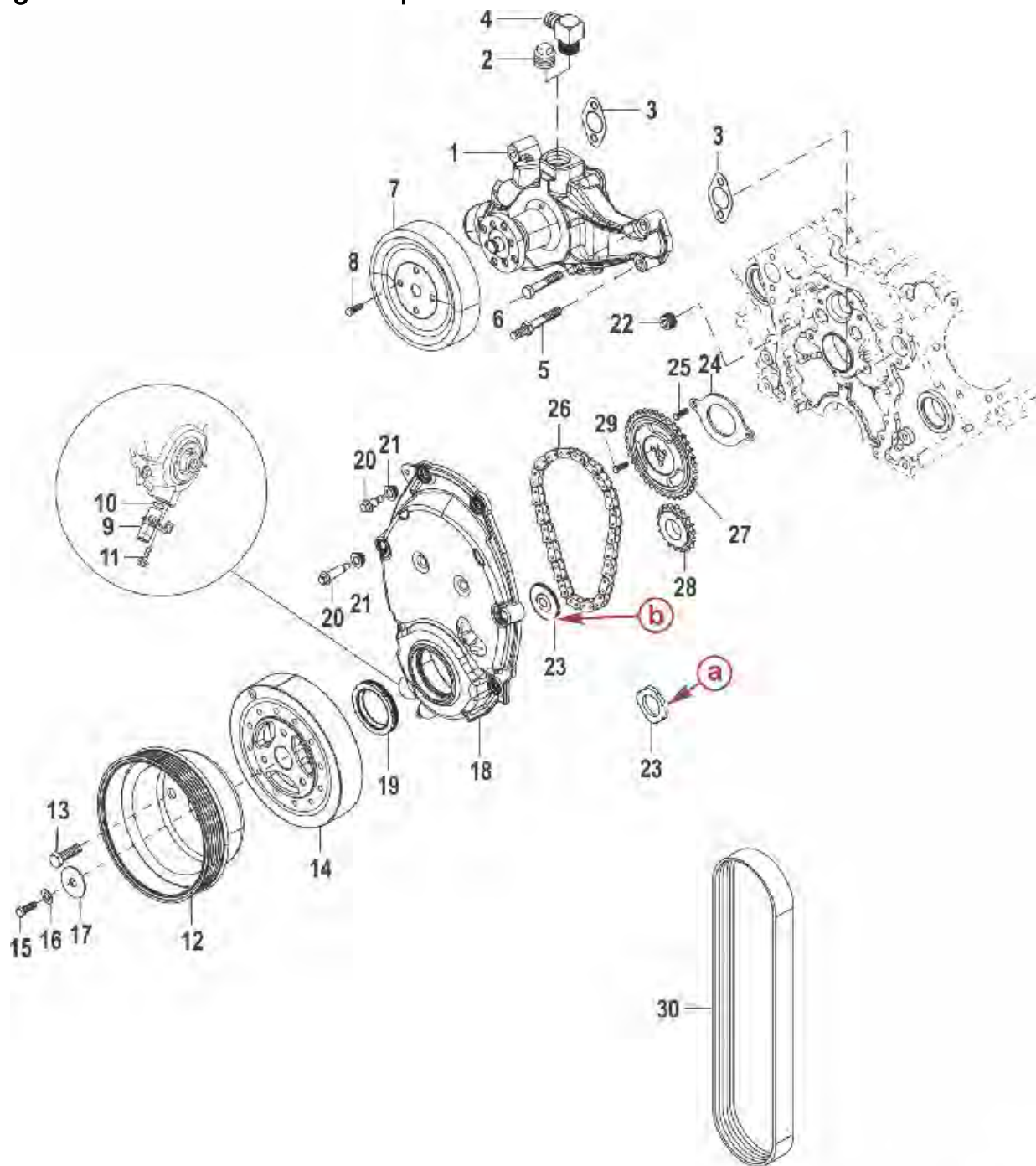


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Cylinder Head and Rocker Cover Components S/N 0M322781 and Above

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Rocker cover			
2	1	Oil fill cap			
3	6	Screw	12	106	–
4	2	Grommet			
5	2	Rocker cover gasket			
6	4	Oil fill tube			
7	12	Push rod			
8	6	Exhaust valve			
9	6	Intake valve			
10	6	Intake valve seal			
10	6	Exhaust valve seal			
11	12	Spring			
12	12	Shield			
13	12	Cap			
14	24	Lock			
15	12	Roller rocker arm	30	–	22
16	2	Rocker arm support			
17	2	Cylinder head			
18	2	Head gasket			
19	12	Screw (0.437-14 x 1.750)	First torque	30	–
			Final torque	+55°	
20	4	Screw (0.437-14 x 3.00)	First torque	30	–
			Final torque	+65°	
21	10	Screw (0.437-14 x 3.750)	First torque	30	–
			Final torque	+75°	
22	1	Hose (16.50 in.)			
23	1	Breather elbow			
24	2	Clamp			
25	1	Hose (33.00 in.)			
26	1	PCV valve			
27	1	Fitting			

Timing Chain and Front Cover Components S/N 0M322781 and Above



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Timing Chain and Front Cover Components S/N 0M322781 and Above

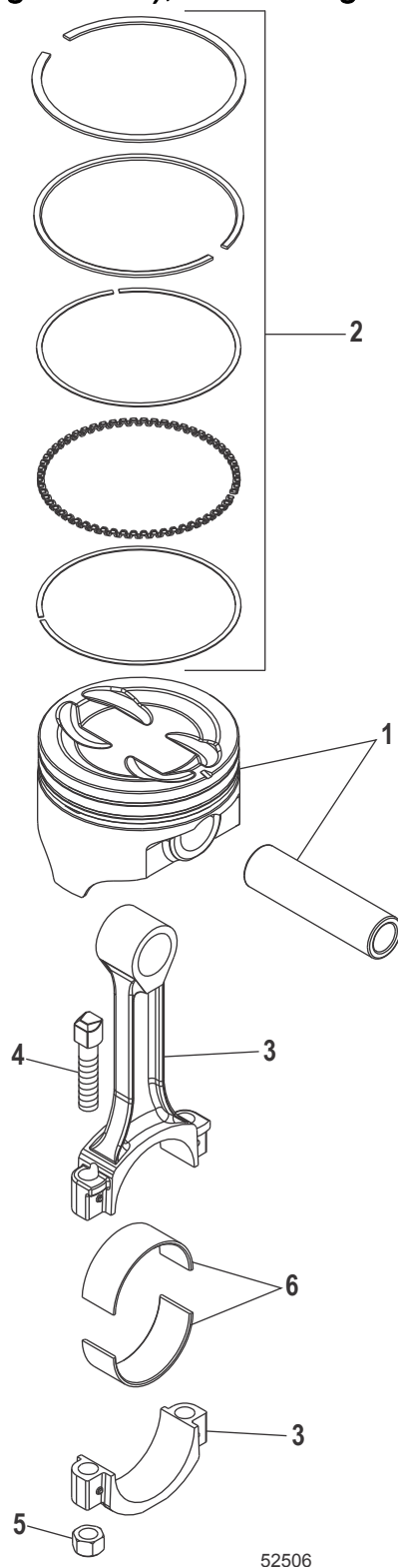
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Water pump			
2	1	Pipe plug (standard cooling)			
3	2	Water pump gasket	12	106	–
4	1	Elbow fitting (closed cooling)			
5	2	Stud (0.312-24/ 0.375-16 x 2.5625)	45	–	33
6	2	Screw (0.312-16 x 1.750)	45	–	33
	1	Screw (0.312-16 x 2.750)			
7	1	Pulley			
8	4	Screw (0.321-24 x 0.750)	25	–	18
9	1	Crankshaft position sensor			
10	1	O-ring			
11	1	Screw	9	80	–
12	1	Crankshaft pulley			
13	3	Screw (0.375-24 x 0.875)	58	–	43
14	1	Crankshaft balancer			
15	1	Screw (0.437-20 x 2.50)	95	–	70
16	1	Lockwasher (0.437)			
17	1	Washer			
18	1	Timing cover			
19	1	Oil seal			
20	6	Bolt	12	106	–
21	6	Grommet			
22	1	Cup plug (0.468)			
23-a	1	Reluctor wheel 3X (S/N 1A063239 and below)			
23-b	1	Reluctor wheel 58X (S/N 1A063240 and above)			
24	1	Camshaft retainer			
25	2	Screw (0.250-20 x 0.500)	12	106	–
26	1	Timing chain			
27	1	Camshaft sprocket			
28	1	Crankshaft sprocket			
29	3	Screw (0.312-18 x 0.750)	25	–	18
30	1	Belt			



Crankshaft, Camshaft, and Balanced Shaft

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Crankshaft bearing set			
2	2	Dowel pin			
3	1	Crankshaft			
4	2	Key			
5		Crankshaft bearing cap (NSS)			
6	8	Screw	First torque	20	177
			Final torque	+73°	
7	5	Stud	One pass - All bolts evenly	105	–
8	1	Cam bearing set			
9	6	Lifter guide			
10	12	Roller lifter			
11	1	Camshaft			
12	1	Dowel pin			
13	2	Lifter guide retainer			
14	3	Screw (0.312-18 x 0.625)	16	142	–
15	1	Fitting	15	133	–
16	1	Sensor oil pressure			
17	1	Sender oil pressure			
18	1	Stainless lockwasher (#10)			
19	1	Stainless nut (#10-32)			
20	1	Balanced shaft			
21	1	Bearing (NSS)			
22	6	Needle bearing			
23	1	Balance shaft retainer			
24	2	Screw (0.250-20 x 0.500)	12	106	–
25	1	Balance shaft gear set			
26	1	Screw	First torque	20	177
			Final torque	+35°	
27	3	Screw (0.312-18 x 0.750)	25	–	18
28	1	Camshaft retainer			
29	2	Screw	12	106	–
30	1	Oil filter			
31	1	Adapter			
32	1	Bypass valve			

Piston and Connecting Rod (Forged Steel), Connecting Rod with Nuts

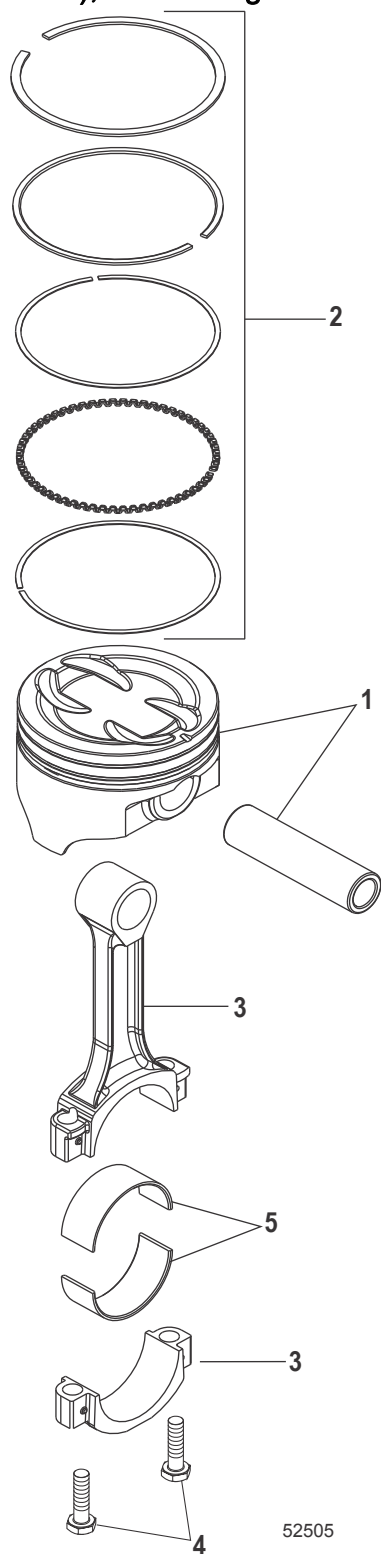


52506

Piston and Connecting Rod (Forged Steel), Connecting Rod with Nuts

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	6	Piston assembly				
2	6	Ring set				
3	6	Connecting rod				
4	12	Bolt				
5	12	Nut	First torque	27	–	20
			Final (angle torque)	+ 70°		
6	6	Bearing				

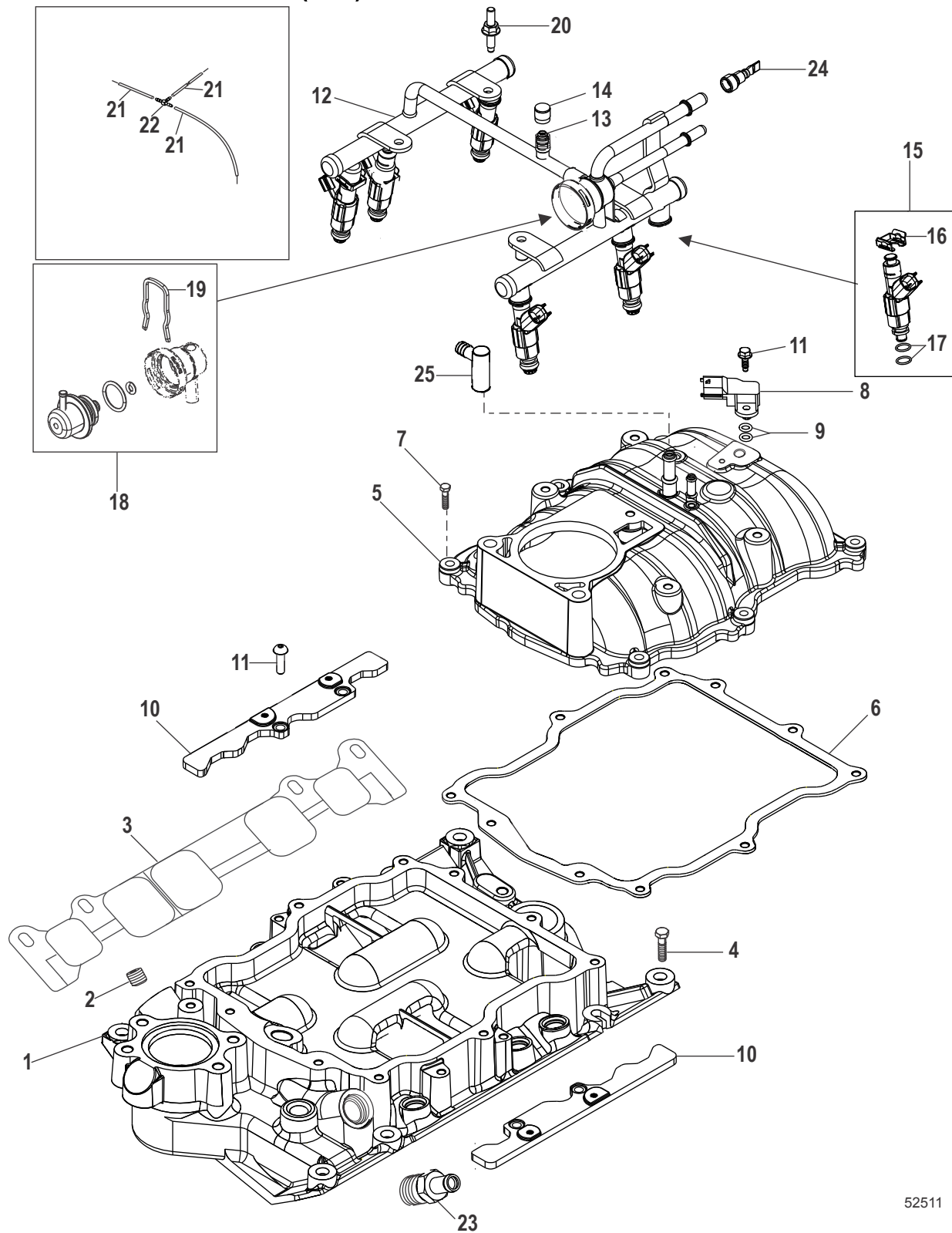
Piston and Connecting Rod (Powder Metal), Connecting Rod with Captured Bolts



Piston and Connecting Rod (Powder Metal), Connecting Rod with Captured Bolts

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	6	Piston assembly				
2	6	Ring set				
3	6	Connecting rod				
4	12	Bolts	First torque	20	177	–
			Final (angle torque)	+ 100°		
5	6	Bearing				

Intake Manifold and Fuel Rail (MPI)

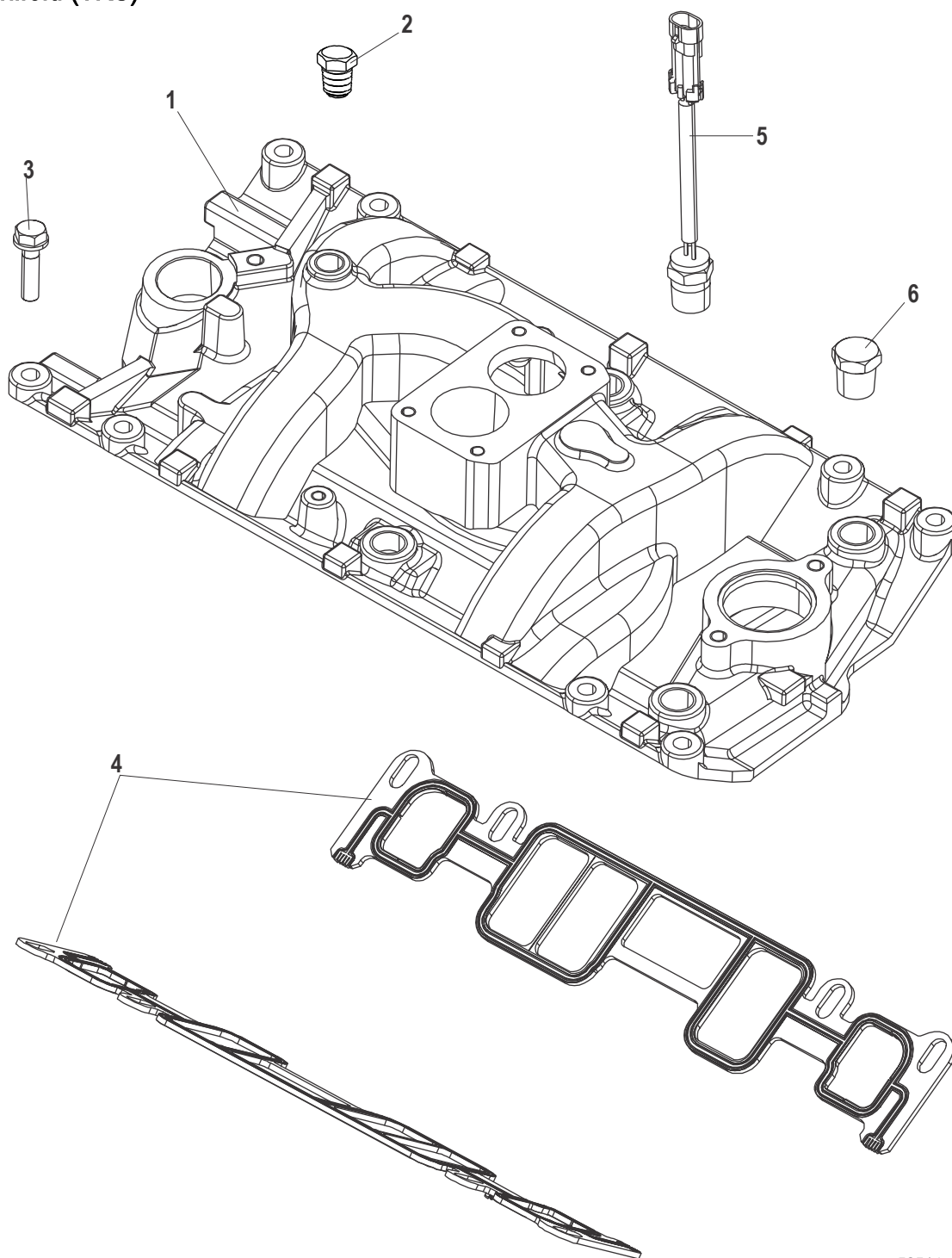


52511

Intake Manifold and Fuel Rail (MPI)

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Lower manifold				
2	1	Plug (0.375)				
3	1	Gasket set				
4	8	Screw (0.312-18 x 1.375)	First torque	3	27	–
			Second torque	12	106	–
			Final	15	133	–
5	1	Upper manifold				
6	1	Gasket				
7	8	Screw	First torque	5	44	–
			Final torque	9	80	–
8	1	Manifold absolute pressure and temperature (MAPT) sensor				
9	2	Seal				
10	2	Bracket (NSS) part of lower manifold				
11	4	Screw				
12	1	Fuel rail				
13	1	Fuel service valve				
14	1	Cap fuel service valve				
15	6	Injector				
16	1	Retainer				
17	1	O-ring kit				
18	1	Fuel pressure regulator				
19	1	Clip				
20	4	Screw				
21	3	Hose (58.00 in.)				
22	1	T-fitting				
23	1	EGR plug fitting				
24	1	Fuel rail block off plug				
25	1	90 degree fitting				

Intake Manifold (TKS)

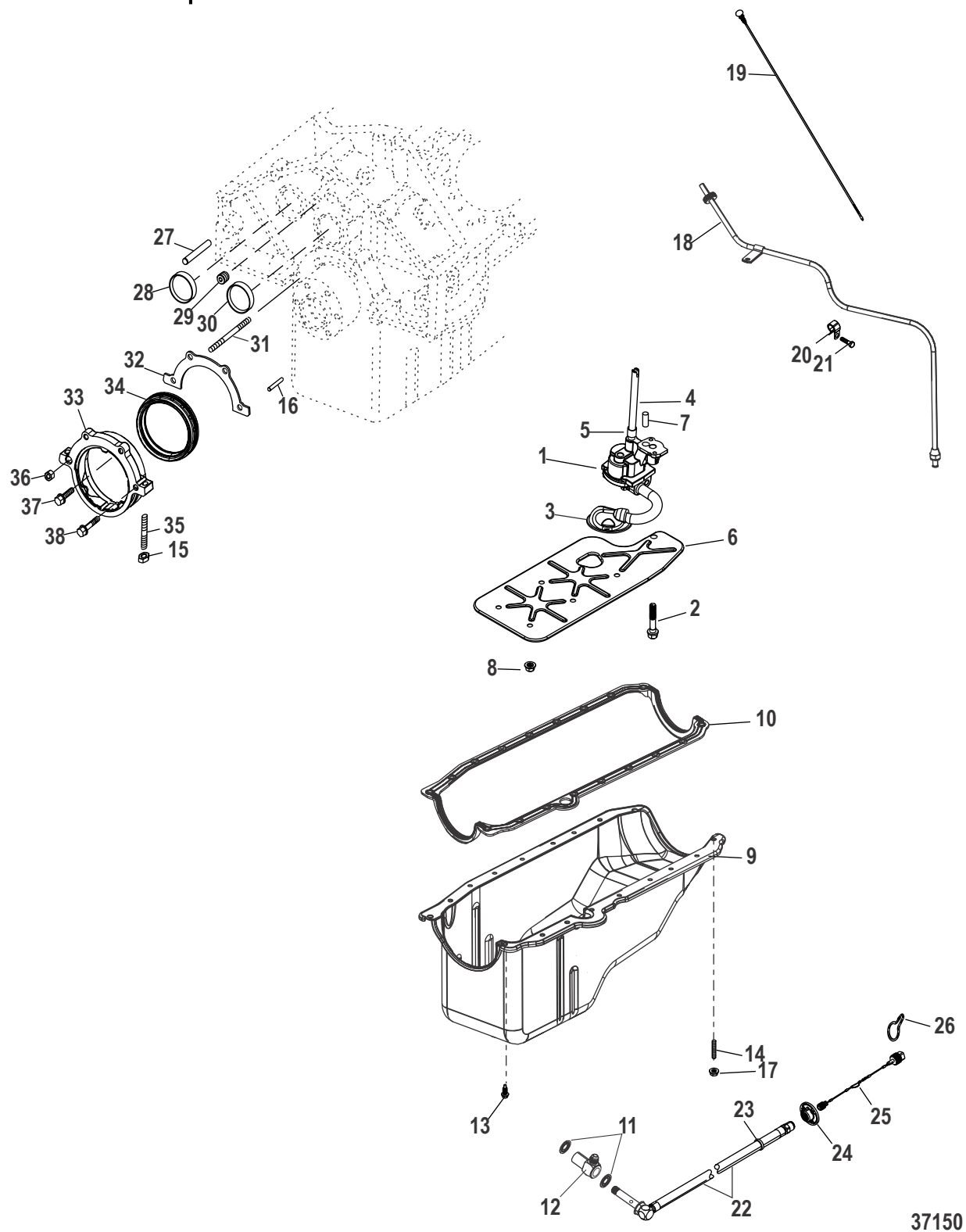


52514

Intake Manifold (TKS)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Intake manifold			
2	1	Plug			
3	8	Bolt (0.321-18 x 1.75)	15	133	–
4	1	Gasket set			
5	1	Thermal switch			
6	1	Plug (0.500)			

Oil Pan and Oil Pump



Oil Pan and Oil Pump

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Oil pump			
2	1	Screw	90	–	66
3	1	Oil pump screen			
4	1	Oil pump shaft			
5	1	Oil pump shaft retainer			
6	1	Oil deflector			
7	1	Alignment pin			
8	5	Nut	40	–	30
9	1	Oil pan			
10	1	Gasket			
11	2	Oil drain gasket			
12	1	T-fitting			
13	10	Screw (5/16-18 x 0.875)	25	–	18
14	2	Stud (5/16-18 x 1.67)	6	53	–
15	2	Nut (0.312-18)	25	–	18
16	1	Dowel pin			
17	4	Nut (0.312-18)	25	–	18
18	1	Dipstick tube			
19	1	Dipstick			
20	1	Clip			
21	1	Screw			
22	1	Oil drain hose			
23	1	Clamp			
24	1	Flange			
25	1	Tether assembly			
26	1	Clip			
27	1	Dowel pin			
28	1	Expansion plug			
29	3	Oil galley plug	20	177	–
30	1	Camshaft bearing hole plug			
31	2	Stud	6	53	–
32	1	Gasket			
33	1	Oil seal retainer			
34	1	Crankshaft oil seal			
35	1	Stud	6	53	–
36	1	Nut	12	106	–
37	2	Screw (0.250-20 x 0.875)	12	106	–
38	1	Screw (0.250-20 x 1.750)	12	106	–

General Information

Repair Guidelines

- Follow all warnings, cautions, and notices contained in this manual.
- Disconnect the battery prior to performing any repair procedures.
- Boat design factors and the nature of particular repairs may require that the engine be removed from the boat. Place the engine on a repair stand for major repairs.
- Lubricate all moving parts during assembly with clean engine oil or as specified. Apply appropriate lubricant, sealant, or adhesive to all fasteners as specified.

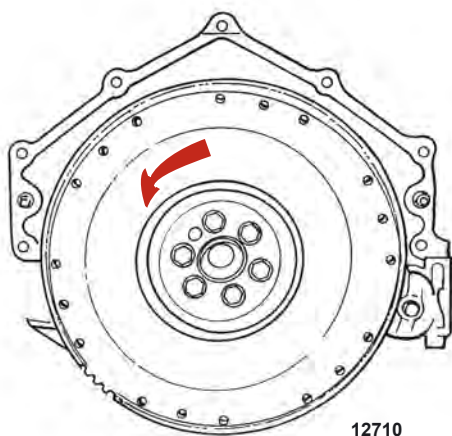
IMPORTANT: To facilitate service or repair, some external components that are not mentioned in this section's procedural steps must be removed. Refer to the appropriate sections of this manual for service information concerning any external component that interferes with engine service or repair.

Engine Rotation

Engine rotation is observed from the rear of the engine (transmission or sterndrive end) looking forward (water pump end).

Engine rotation is not necessarily the same as propeller rotation .

IMPORTANT: All engines covered by this service manual are left-hand (LH) rotation.

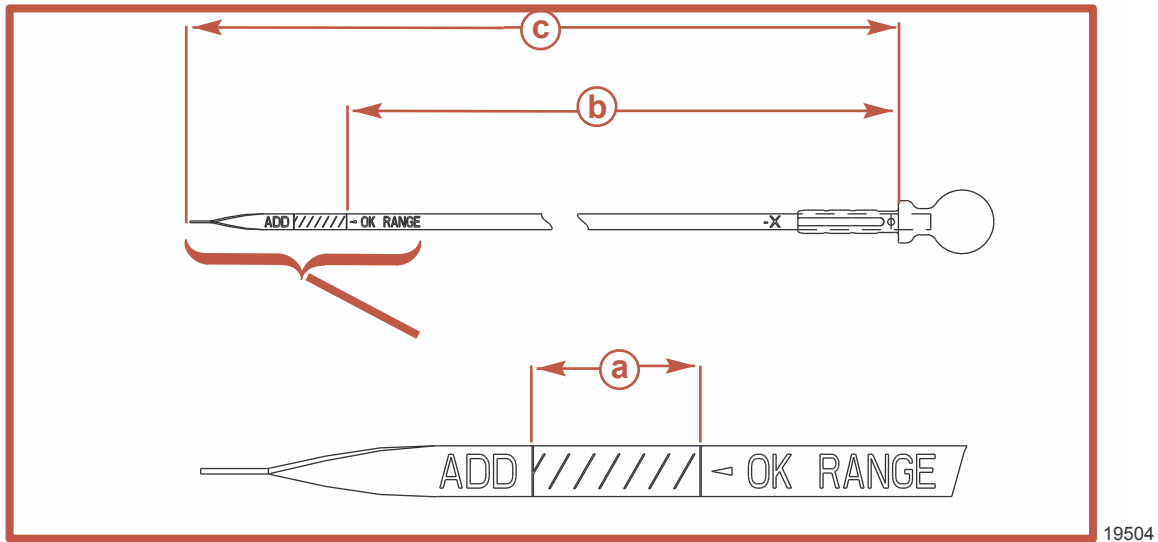


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Left-hand rotation (counter clockwise)

Crankcase Oil Dipstick Measurements

IMPORTANT: Crankcase dipsticks from different applications are not interchangeable.



- a** - Length "A"
- b** - Length "B"
- c** - Length "C"

Part number	Length "A"	Length "B"	Length "C"	Model
861942-2	19 mm (3/4 in.)	330 mm (13 in.)	396 mm (15 1/2 in.)	MIE engines
861942-3	13 mm (1/2 in.)	349 mm (14 in.)	396 mm (15 1/2 in.)	MIE engines with remote drive transmissions
861942-7	19 mm (3/4 in.)	787 mm (31 in.)	845 mm (33 1/4 in.)	MCM service and towports engines
861942-9	13 mm (1/2 in.)	851 mm (33 1/2 in.)	895 mm (35 1/4 in.)	ALL OEM MCM engines

Valve Cover

Removal

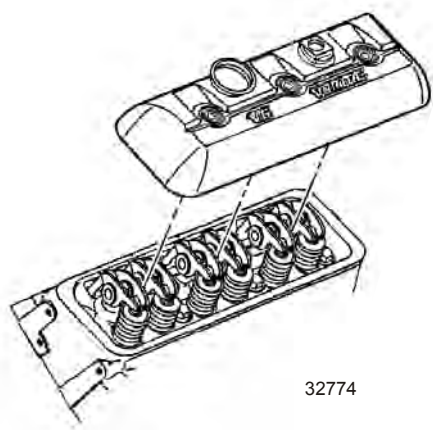
NOTE: For some applications it may be necessary to remove the exhaust manifold before removing a rocker arm cover. See **Section 7** for exhaust manifold removal.

1. Disconnect the crankcase ventilation hoses.
2. Remove any items that interfere with the removal of the rocker arm covers.
3. Remove the rocker arm covers.

Cleaning and Inspection

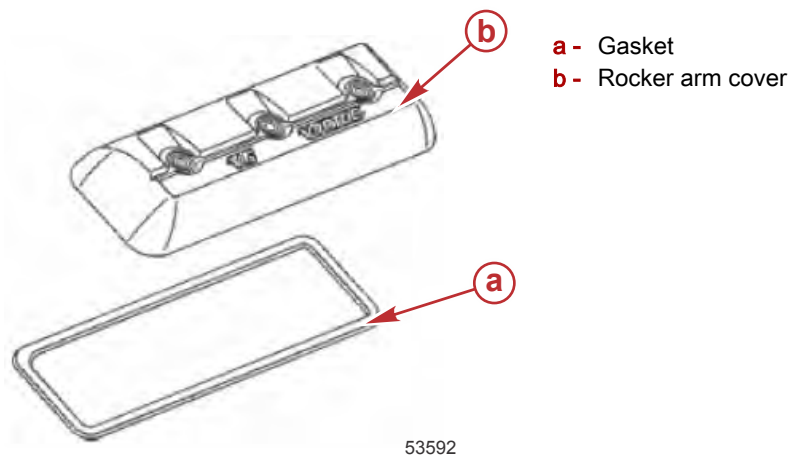
1. Remove any gasket material on the cylinder head and rocker arm cover sealing surfaces.

- 2. Clean all sealing surfaces with degreaser.



Installation

- 1. Place a new rocker arm cover gasket in position.



- 2. Install the rocker arm cover. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft.
Rocker arm cover bolt	12	106	–

- 3. Install any items that were removed.
- 4. Connect crankcase ventilation hoses.
- 5. Supply cooling water to the power package.
- 6. Start the engine and check for oil leaks.

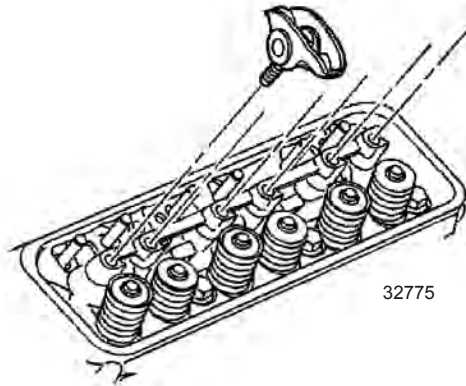
Rocker Arms and Valve Pushrods

Removal

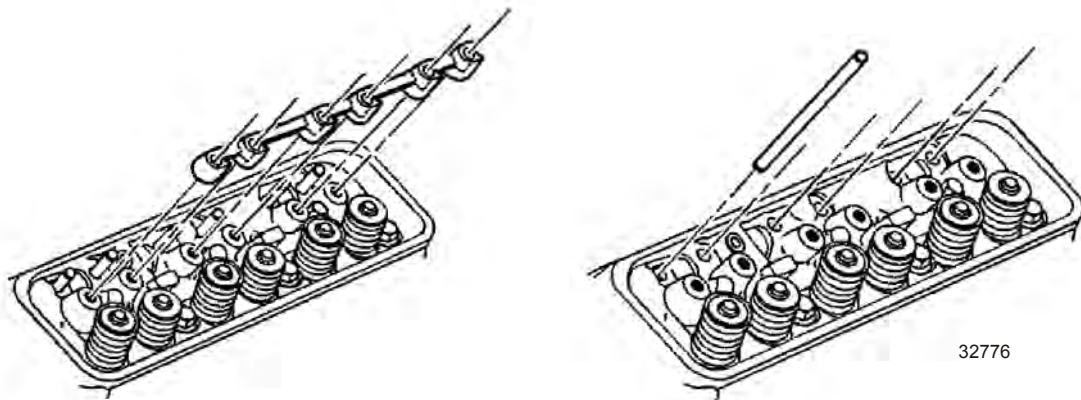
NOTE: When servicing only one cylinder's rocker arms, bring that cylinder's piston up to top dead center (TDC) before removing the rocker arms. When servicing all rocker arms, bring cylinder number 1 piston up to TDC before removing rocker arms.

- 1. Remove the rocker arm covers.

2. Remove the rocker arms.



3. Remove the rocker arm assemblies and pushrods.



NOTE: Organize and store the rocker arm assemblies and pushrods in sets for assembly in their original locations.

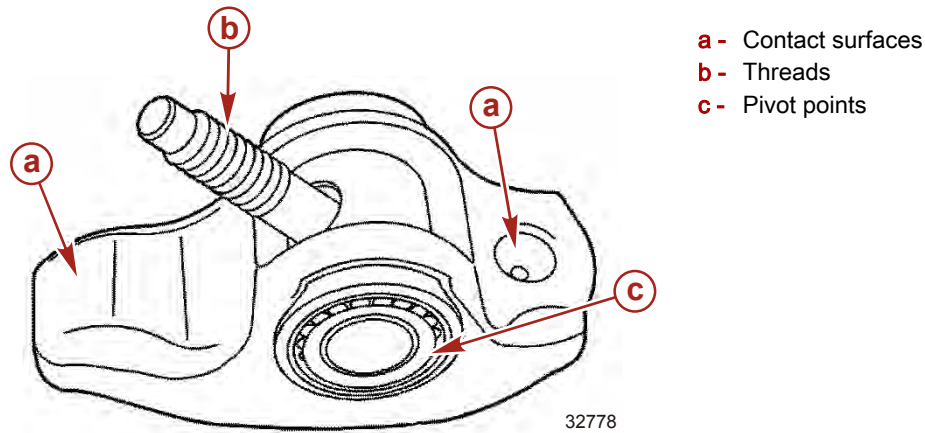
Cleaning

1. Clean the rocker arm assemblies and pushrods with degreaser.
2. Clean the pushrod oil passages.
3. Dry components with compressed air.

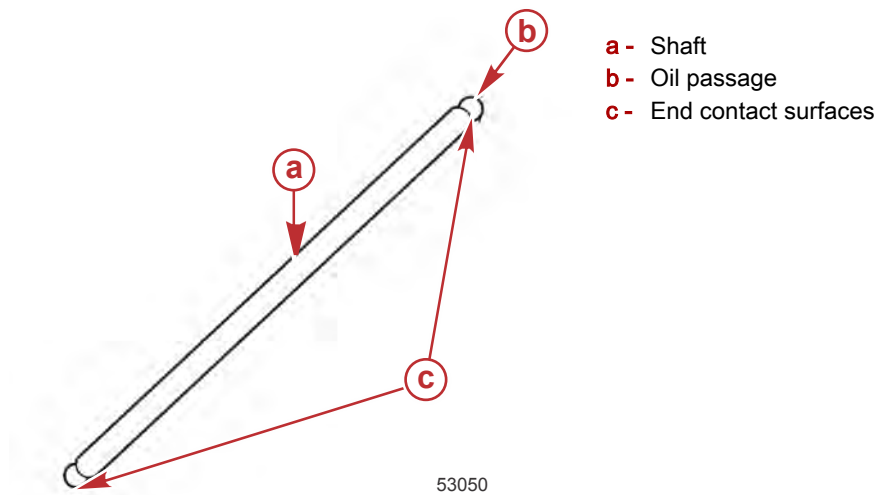
Inspection

1. Inspect all contact surfaces for excessive wear or scoring.
2. Inspect threads for damage.

3. Inspect pivot points for binding or damage.



4. Inspect the pushrods.

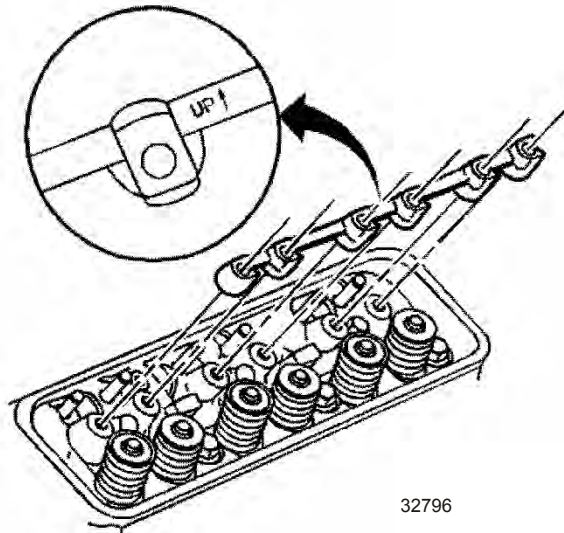


- a. Inspect shaft for bends.
 - b. Inspect for oil passage restriction.
 - c. Inspect for wear or scoring of the end contact surfaces.
5. Replace any damaged or excessively worn components.

Installation

1. Lubricate the outer surfaces and ends of valve pushrods.
2. Install the valve pushrods in their original locations. Ensure that the pushrods seat in the lifter socket.

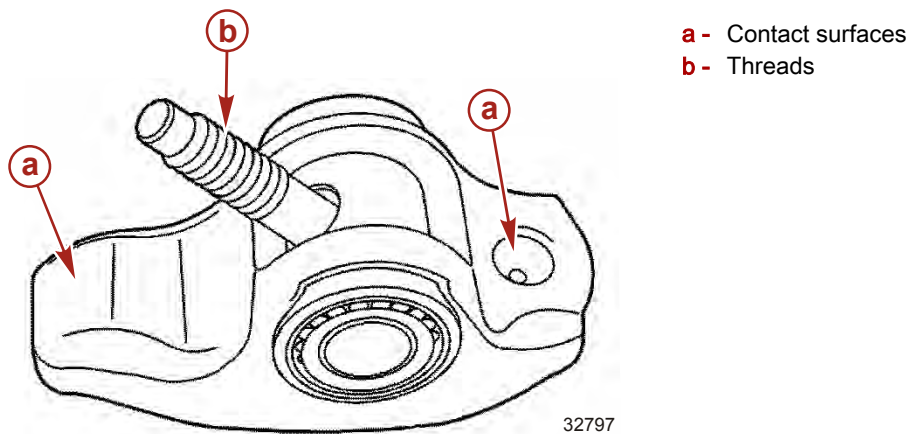
3. Install the rocker arm supports.



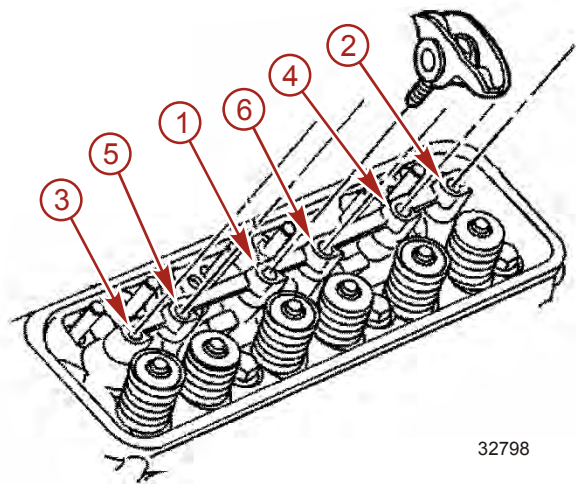
4. Lubricate the rocker arm and rocker arm ball contact surfaces.

Tube Ref No.	Description	Where Used	Part No.
 79	MerCruiser 4-Cycle 25W-40 Engine Oil	Rocker arm	92-858048K01

5. Lubricate the threads of the valve rocker arm studs.



6. Install the rocker arm assemblies in their original locations.

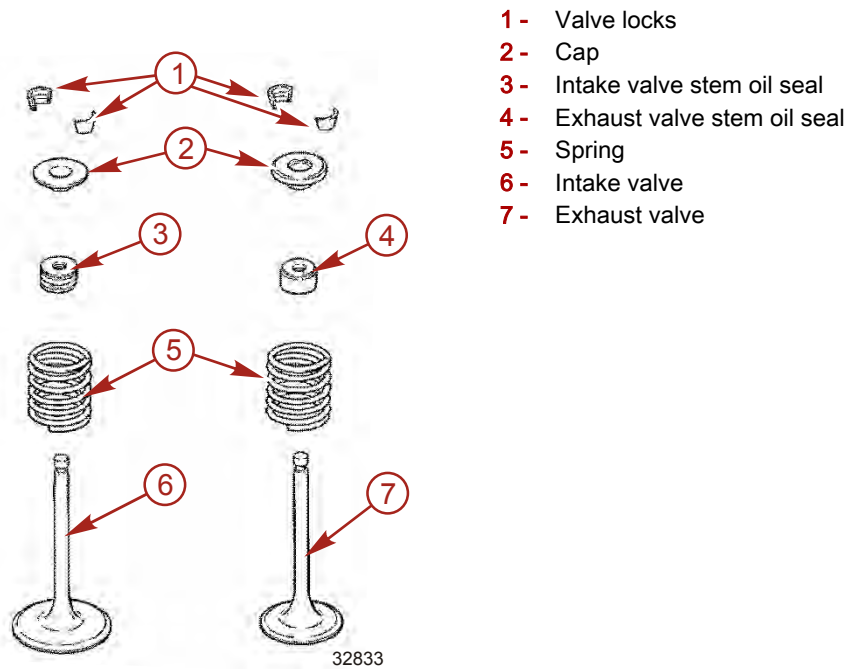


Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Valve pushrods, rocker arm and rocker arm ball contact surfaces	92-858058K01

7. Tighten rocker arm bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Rocker arm bolts	30	–	22

Valve Stem Oil Seal and Valve Spring—Cylinder Head Installed Exploded View



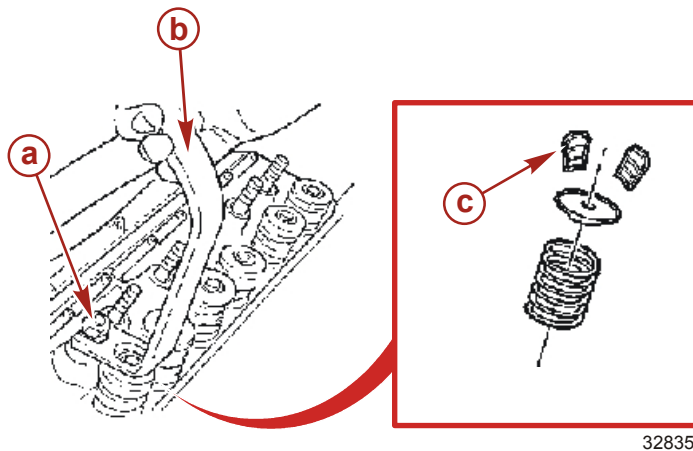
Removal

1. Remove the valve cover.
2. Remove the spark plug of the affected cylinder.
3. Remove the rocker arm assembly.
IMPORTANT: Keep air pressure in the cylinder while the springs, caps, and valve locks are removed or the valves will fall into the cylinder.
4. Install the air line adapter tool (J23590) in the spark plug hole and apply compressed air to hold the valves in place.

Description	Part Number
Kent-Moore air line adapter tool	J23590

NOTE: If compressed air is not available, the piston may be brought up to TDC and used to keep the valves from falling out of the valve guides.

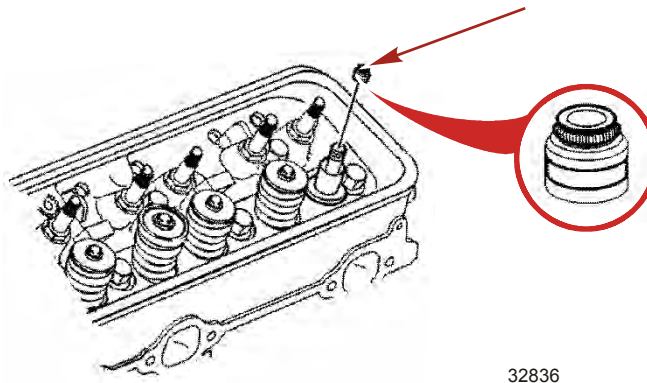
5. Using a valve spring compressor under the rocker arm nut as shown, compress the valve spring, and remove the valve locks.



- a - Valve spring compressor (J5892-D)
- b - Rocker arm nut
- c - Valve locks

Description	Part Number
Kent-Moore valve spring compressor	J5892-D

6. Slowly release the valve spring compressor.
7. Remove the valve spring cap and valve spring.
IMPORTANT: If compressed air was not available, do not turn the crankshaft while the valve springs, retainers, and locks are removed or valves will fall into the cylinder.
8. Remove and discard the valve stem seal.



Valve stem seal

Installation

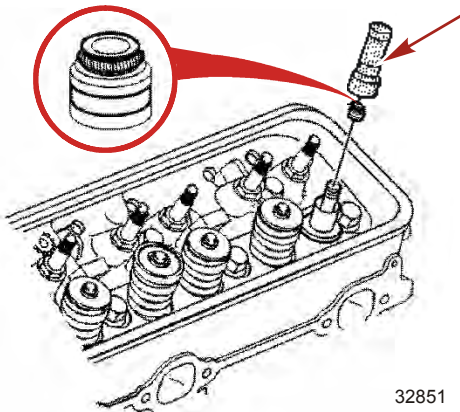
IMPORTANT: The intake valve oil stem seal is black. The exhaust valve stem seal material is either brown with a white paint stripe on the outer diameter or it is red with no paint stripe. Also, the letters "EX" are molded into the top of the exhaust valve stem seal.

NOTE: Engine serial number M615000 and above use brown color exhaust valve oil seals. Engine serial number M300000–M614599 use an O-ring and shield on exhaust valves.

- 1. Select the appropriate intake or exhaust valve stem oil seal.
- 2. Coat the outside surface of the valve stem bore and all surfaces of the valve stem oil seal with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Outside surface of valve stem bore and all surfaces of valve stem oil seal	Obtain Locally

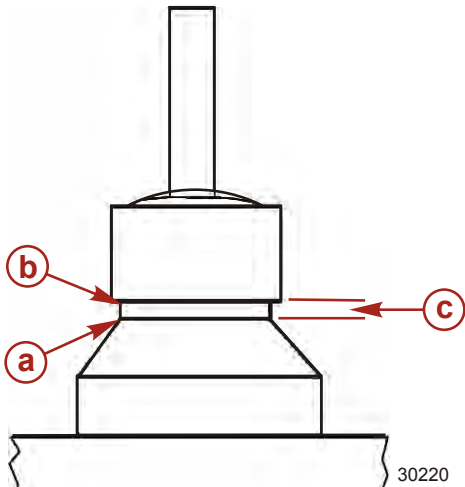
- 3. Install the valve stem seal onto the valve stem and push down until it is seated against the head.
- 4. Install special valve stem seal installer tool and press the valve stem seal until the tool contacts the spring seat.



Valve stem seal installer tool (J42073)

Description	Part Number
Valve stem seal installer tool	J42073

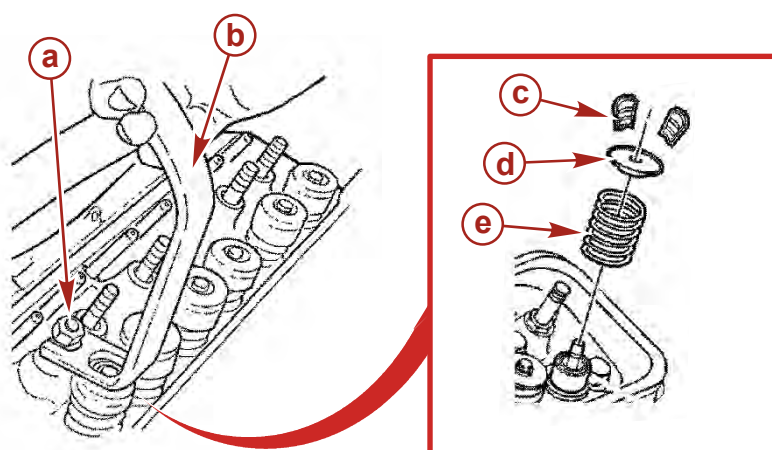
- 5. For all intake and exhaust valves, ensure that the installed height (the gap between the bottom edge of the valve stem oil seal and the cylinder head valve guide boss) is as specified.



- a - Valve guide boss
- b - Bottom of valve stem oil seal
- c - Installed height (gap)

Description		4.3 Liter (262 cid)
Valve stem oil seal	Installed Height NOTE: Measured from top of valve guide bevel to bottom of oil stem seal.	1–2 mm (0.0394–0.0787 in.)

6. Install the valve spring.
7. Place the valve spring cap on the valve spring.
8. Temporarily install the rocker arm nut onto the corresponding stud.
9. Coat the valve stem locks with the lubricant to hold them in place.
10. While compressing valve spring with the valve spring compressor, install the valve stem locks.
11. Ensure that the valve stem locks are seated properly in the groove of the valve stem.
12. Slowly release the valve spring compressor and remove the rocker arm nut.



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- a - Nut
- b - Valve spring compressor (J5892-D)
- c - Valve stem locks
- d - Cap
- e - Valve spring

Tube Ref No.	Description	Where Used	Part No.
 4	Needle Bearing Assembly Lubricant	Valve stem locks	8M0071836

13. Install the pushrods and rocker arm assemblies. Tighten the rocker arm bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Rocker arm bolts	30	–	22

14. Remove the airline adapter tool (J23590).
15. Install the valve cover.
16. Install and tighten the spark plugs to the specified torque.

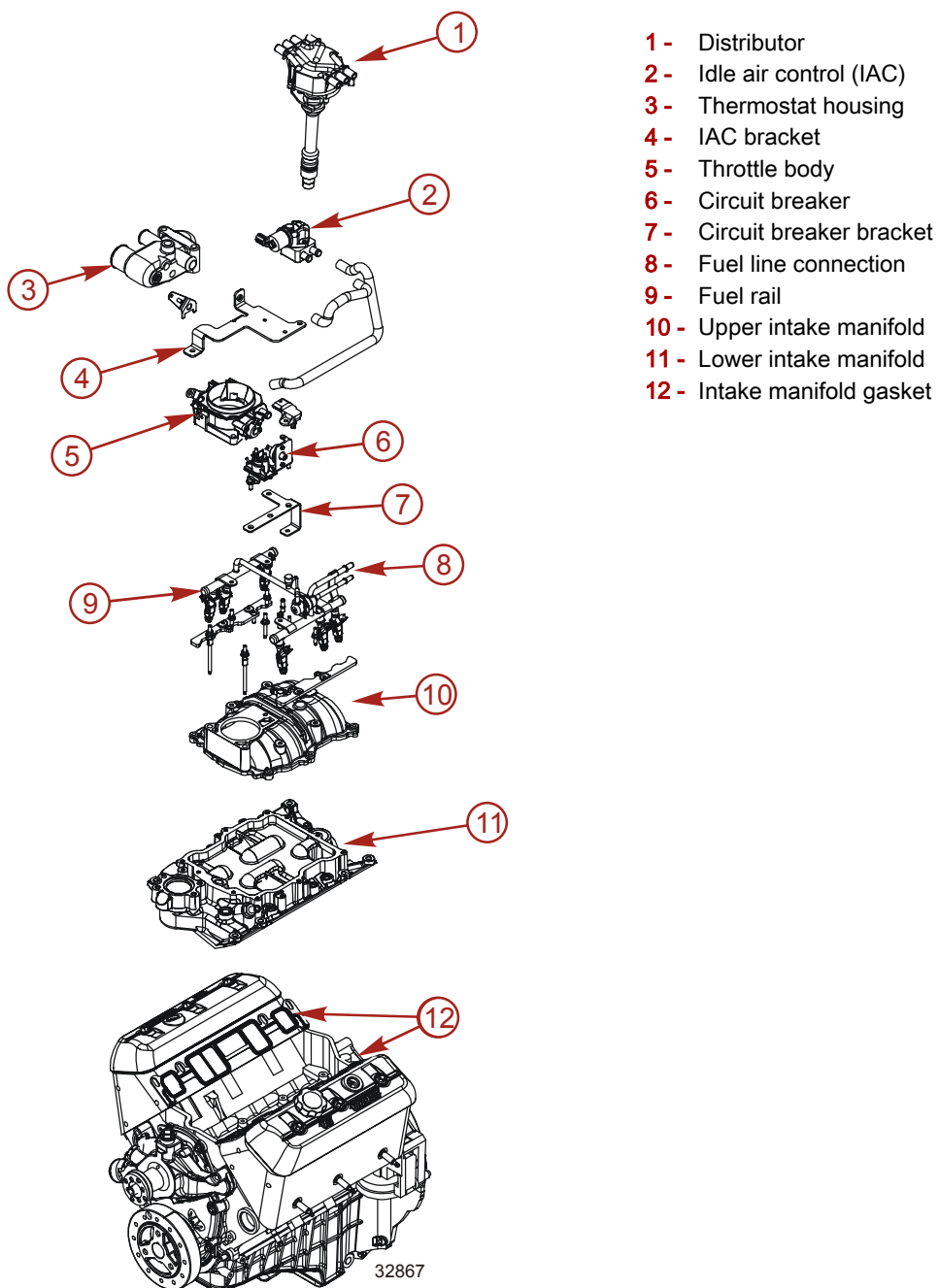
Description		Nm	lb-in.	lb-ft
Spark plug	Initial installation (new cylinder head)	30	–	22
	All subsequent installations	15	133	–

Intake Manifold Assembly

MPI Intake Manifold Assembly

NOTE: The upper and lower intake manifold parts may be removed as an assembly. Unless service is required, it is not necessary to remove individual intake manifold components other than as outlined. See **Section 5** for disassembly, cleaning, inspection, and reassembly of individual intake manifold components.

Exploded View—MPI



Removal—MPI

NOTE: Refer to **Section 5** for disassembly, cleaning, inspection, and reassembly of individual intake manifold components.

1. Drain the engine cooling systems.
2. Disconnect the hoses from the thermostat housing.
3. Remove the relay bracket with relays.
4. Disconnect the the crankcase ventilation hoses from both rocker arm covers.
5. Disconnect the throttle cable.

⚠ WARNING

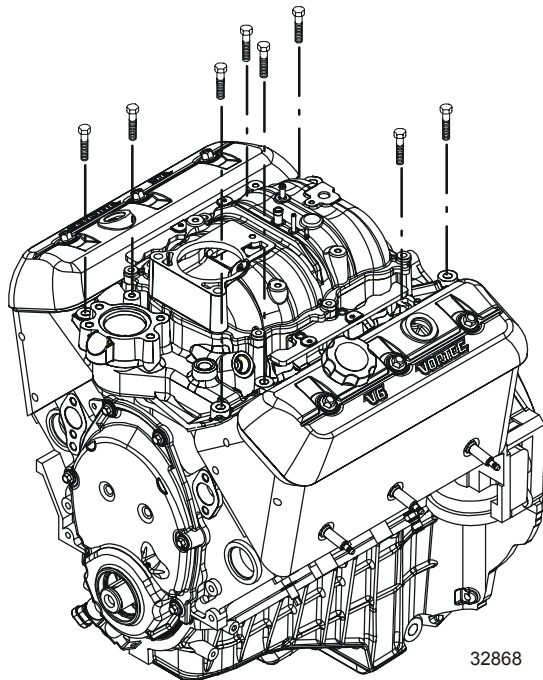
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

IMPORTANT: Do not allow dirt or debris to enter the fuel system. Seal the ends of the open fuel lines.

6. Disconnect the fuel supply line.
7. Remove the ignition coil wire.
8. Remove the distributor cap.
9. Mark the rotor position on the distributor housing and the position of the distributor housing on the intake manifold.
10. Remove the distributor.

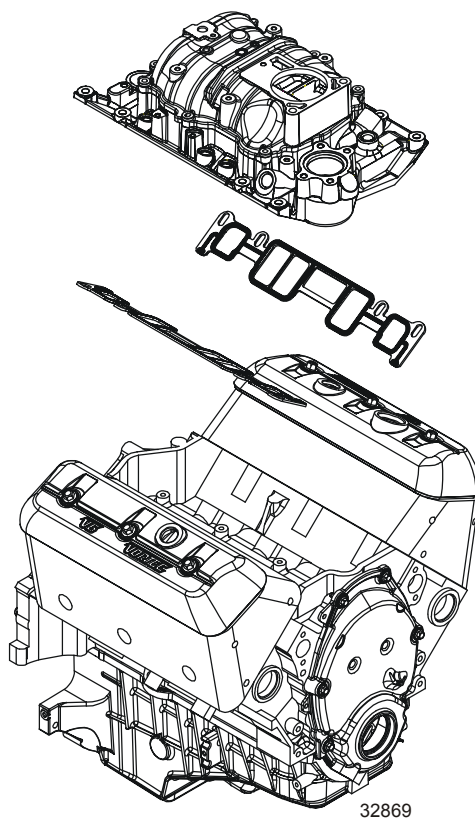
IMPORTANT: Do not crank the engine over after the distributor has been removed.

11. Disconnect the electrical connectors at the fuel injectors.
12. Remove the fuel injectors with the fuel rail.
13. Disconnect all electrical leads interfering with the removal.
14. Disconnect any other items that interfere with the removal of the intake manifold.
15. Remove the lower intake manifold bolts.



IMPORTANT: It may be necessary to pry the intake manifold away from the cylinder heads and block. Use extreme care to prevent damage to the sealing surfaces.

16. Remove the intake manifold assembly.



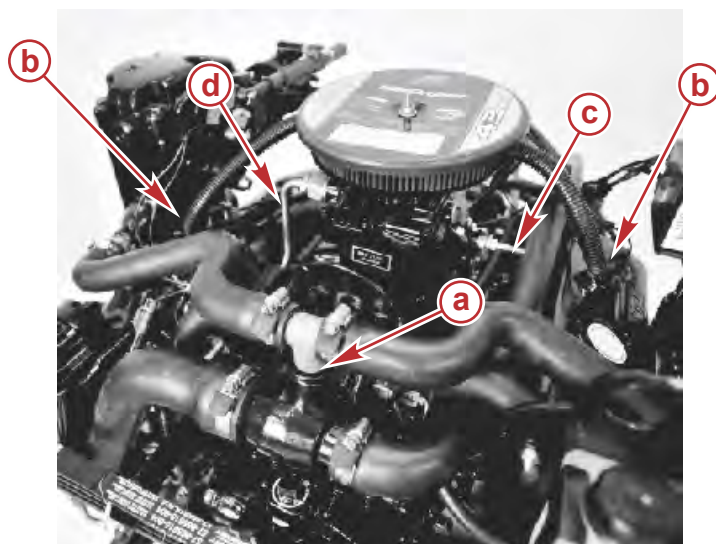
17. Remove and discard the intake manifold gaskets.

NOTE: If the intake manifold requires replacement, transfer all components to the new manifold.

Removal—TKS

NOTE: Refer to **Section 5** for disassembly, cleaning, inspection, and reassembly of individual intake manifold components.

1. Drain the engine cooling systems.



- a - Thermostat housing
- b - Crankcase ventilation hoses
- c - Throttle cable
- d - Fuel line

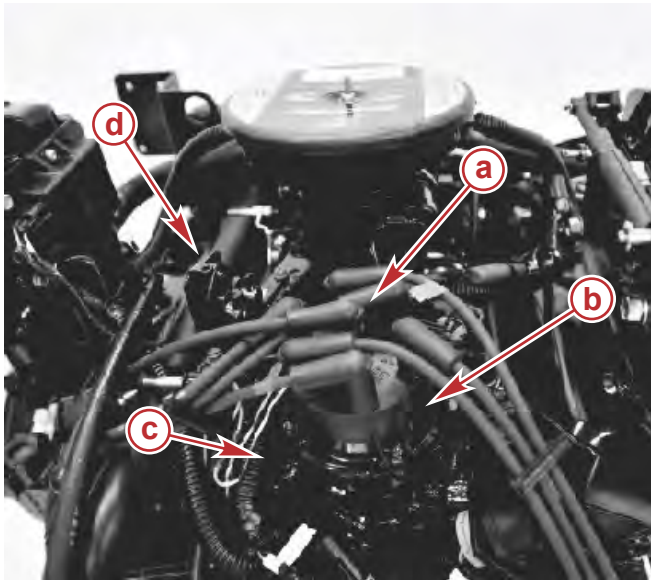
2. Disconnect the hoses from the thermostat housing.
3. Disconnect the crankcase ventilation hoses from both rocker arm covers.
4. Disconnect the throttle cable.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

IMPORTANT: Do not allow dirt or debris to enter the fuel system. Seal the ends of the open fuel lines.

5. Disconnect the fuel line.

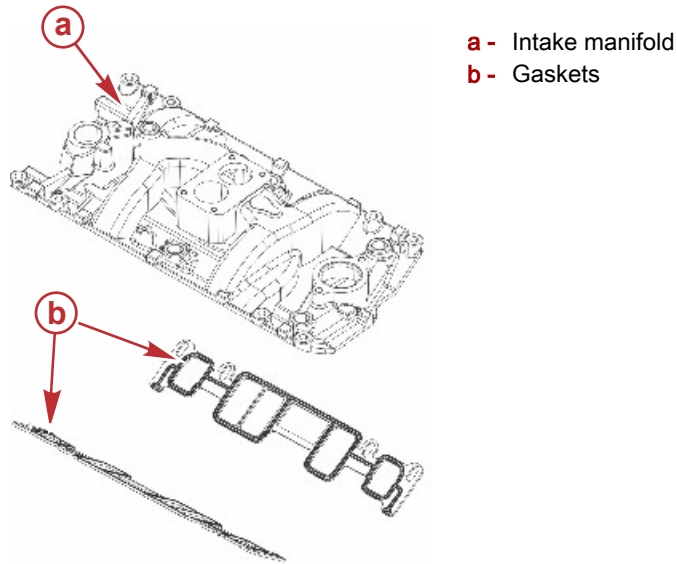


- a - Ignition coil wire
- b - Distributor cap
- c - Oil sending unit
- d - Circuit breaker with bracket

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6. Remove the ignition coil wire.
7. Remove the distributor cap.
8. Mark the rotor position on the distributor housing and the position of the distributor housing on the intake manifold.
IMPORTANT: Do not crank the engine over after the distributor has been removed.
9. Remove the distributor. Refer to **Section 4B**.
10. Disconnect the electrical connectors at the carburetor.
11. Disconnect the circuit breaker with bracket.
12. Remove the oil sending unit.
13. Disconnect any other items that interfere with the removal of the intake manifold.
14. Remove the intake manifold bolts.
IMPORTANT: It may be necessary to pry the intake manifold away from the cylinder heads and block. Use extreme care to prevent damage to the sealing surfaces.

15. Remove the intake manifold.



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16. Remove and discard the intake manifold gaskets.

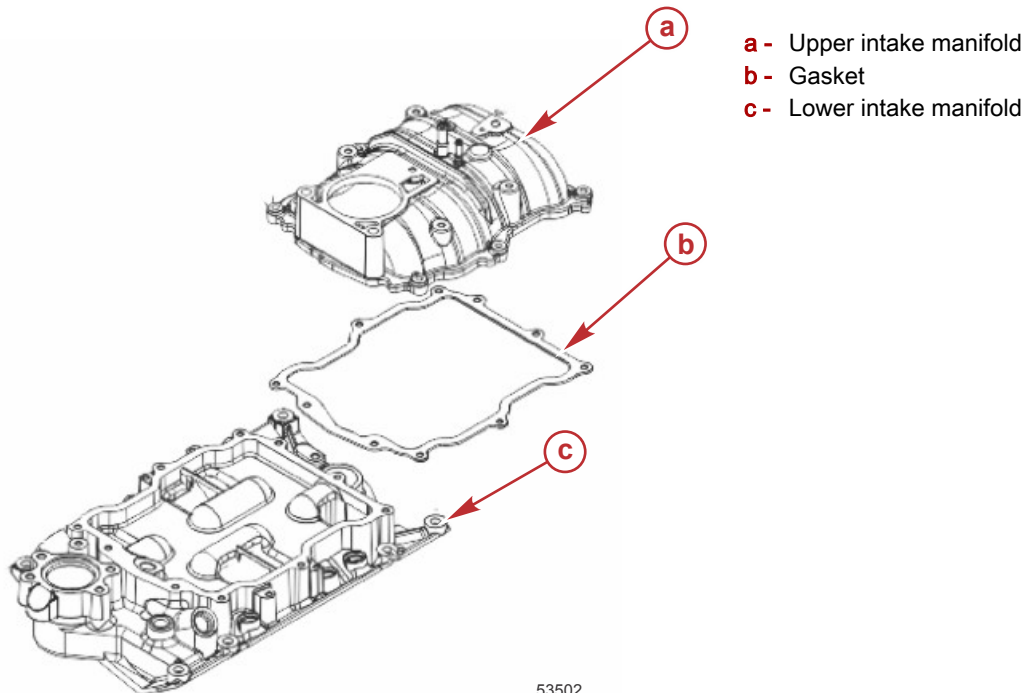
NOTE: If the intake manifold requires replacement, transfer all components to the new manifold.

Cleaning and Inspection

IMPORTANT: When cleaning the cylinder head mating surface, do not allow the gasket material to enter the engine crankcase or intake ports.

1. Clean all gasket material from all mating surfaces.
2. Inspect the intake manifold for cracks or scratches. To properly seal, machined surfaces must be clean and free from scratches.
3. Inspect the intake passages for varnish buildup and other foreign material. Clean as necessary.

Upper and Lower Intake Manifolds



53502

Refer to **Section 5** for disassembly, cleaning, inspection, and reassembly of the individual components.

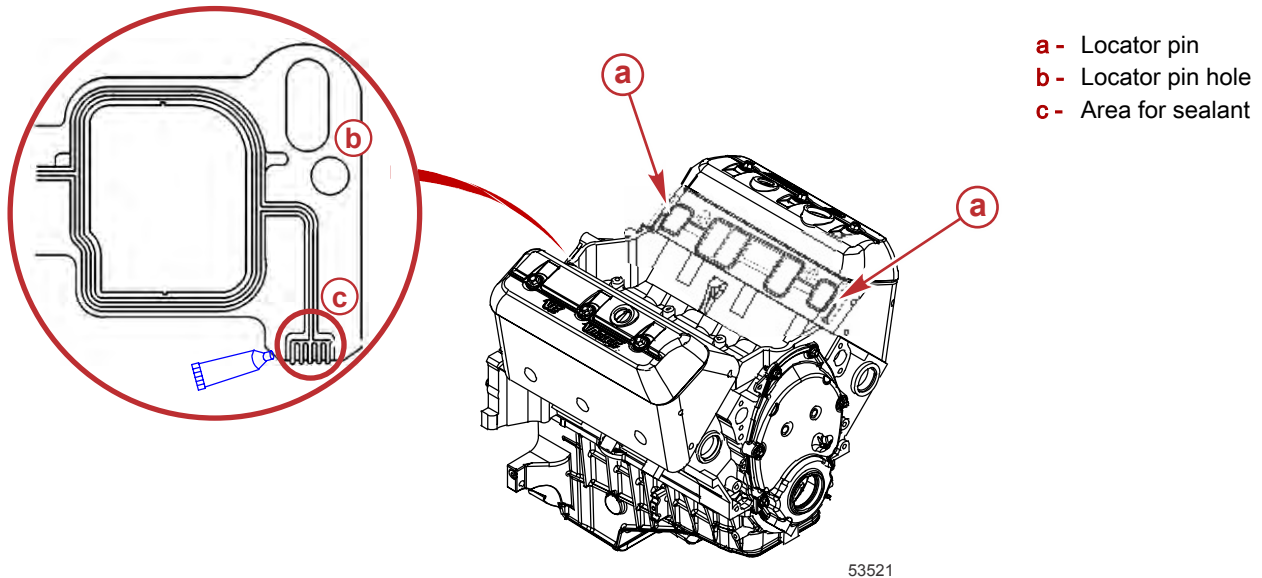
Installation—MPI and TKS

IMPORTANT: Excessive amounts of adhesive or sealer on gaskets or component surfaces may cause improper sealing resulting in intake manifold air or fluid leaks. Do not apply excessive amounts of adhesive or sealer.

1. Apply a 4 mm (5/32 in.) bead of adhesive at each end of the lower intake manifold gasket on the cylinder head side. Do not get sealer into oil sending unit hole.

NOTE: For proper adhesion, the lower intake manifold gasket must be installed while the adhesive is still wet.

2. Align the lower intake manifold gaskets with the locator pins. Install the lower intake manifold gaskets onto the cylinder heads.

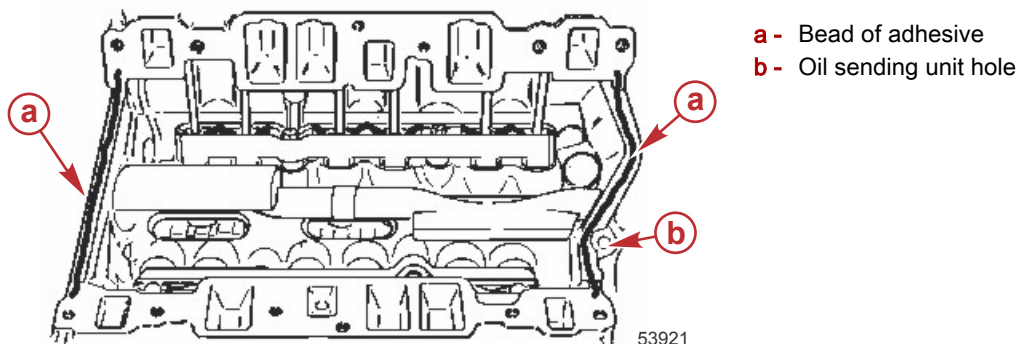


- a - Locator pin
- b - Locator pin hole
- c - Area for sealant

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Lower intake manifold gaskets	92-809826

3. Apply a 5 mm (0.197 in.) wide bead of adhesive to the front and rear of the engine block as shown. Extend the adhesive bead 13 mm (0.50 in.) up on the intake gaskets.

IMPORTANT: Do not get sealer into the oil sending unit hole at the rear of the engine.



- a - Bead of adhesive
- b - Oil sending unit hole

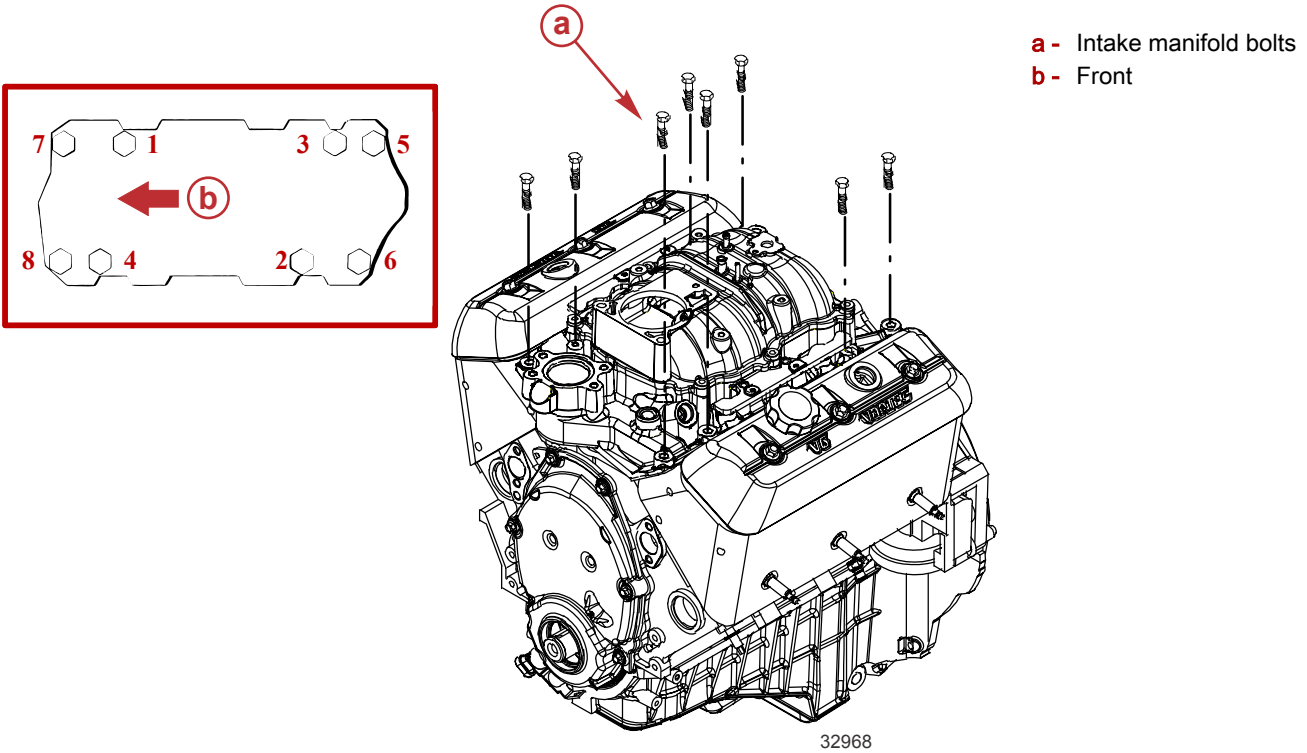
Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Engine block at the lower intake manifold sealing surfaces	92-809826

4. Coat the threads of the lower intake manifold bolts with sealant.
5. Carefully install the lower intake manifold assembly onto the engine block.
IMPORTANT: Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the three passes required.

NOTICE

The crankshaft bearings are matched sets. Mismatching the bearings can result in engine damage. Replace and install the bearings in matched pairs.

6. MPI—Tighten the lower intake manifold bolts to the specified torque in the sequence and steps indicated. TKS—Tighten the intake manifold bolts to the specified torque in the sequence as indicated.



Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Intake manifold bolts	92-809821

Description		Nm	lb-in.	lb-ft
Intake manifold bolts—MPI	First	3	27	–
	Second	12	106	–
	Final	15	133	–
Intake manifold bolts—TKS		15	133	–

7. MPI—Install the injector rail with injectors.
8. MPI—Connect the injector wire harness.
9. Install the fuel line.
10. Install the distributor.

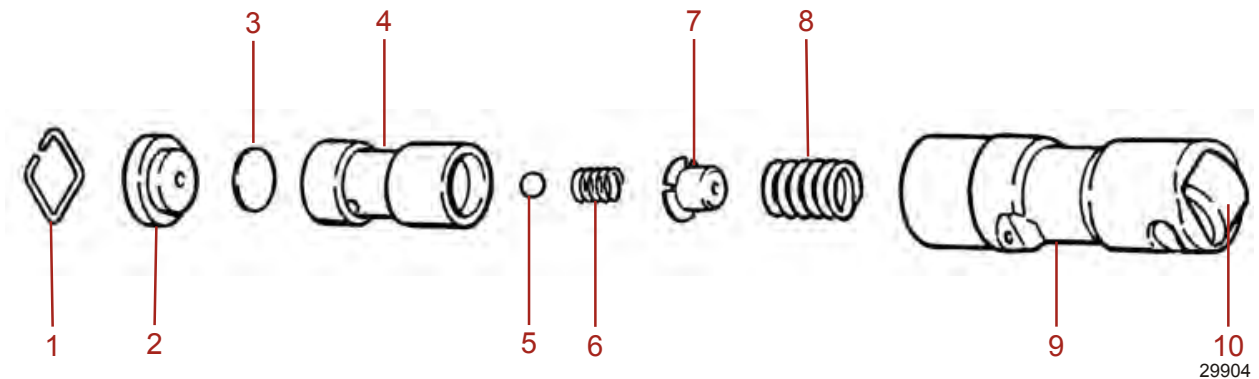
Description	Nm	lb-in.	lb-ft
Distributor hold down clamp bolt—MPI	25	–	18
Distributor hold down clamp bolt—TKS	34	–	25

11. Connect all ignition and electrical leads.
12. Install the ignition coil wire.
13. Install other ignition components and connect the wires.
14. MPI—Install the relay bracket with relays.
15. TKS—Install the circuit breaker with the bracket.
16. Connect the crankcase ventilation hoses.
17. Connect the hoses to the thermostat housing.

18. Connect any items that were disconnected.
19. Refill the closed cooling system, if equipped.

Hydraulic Valve Lifters

Exploded View



- 1 - Pushrod seat retainer clip
- 2 - Pushrod seat
- 3 - Metering valve
- 4 - Plunger
- 5 - Check ball
- 6 - Check ball spring
- 7 - Check ball retainer
- 8 - Plunger spring
- 9 - Lifter body
- 10 - Roller

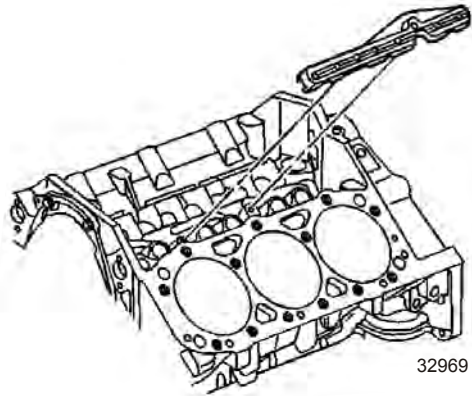
Special Information

Hydraulic valve lifters require little attention. These lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Removal

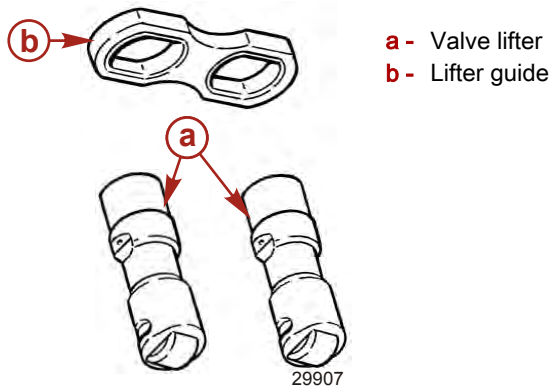
1. Drain the seawater and closed cooling systems.
2. Remove the valve covers.
IMPORTANT: Organize and store the rocker arm assemblies, pushrods, and valve lifters in matched sets for reassembly and installation in their original locations.
3. Remove the rocker arm assemblies and valve pushrods. Keep the parts in matched sets.
4. Remove the intake manifold.

5. Remove the lifter guide retainer.



IMPORTANT: Store the valve lifters in the upright position to prevent oil loss.

6. Remove the lifter guides and valve lifters. Store the lifters in the upright position in the order of removal.

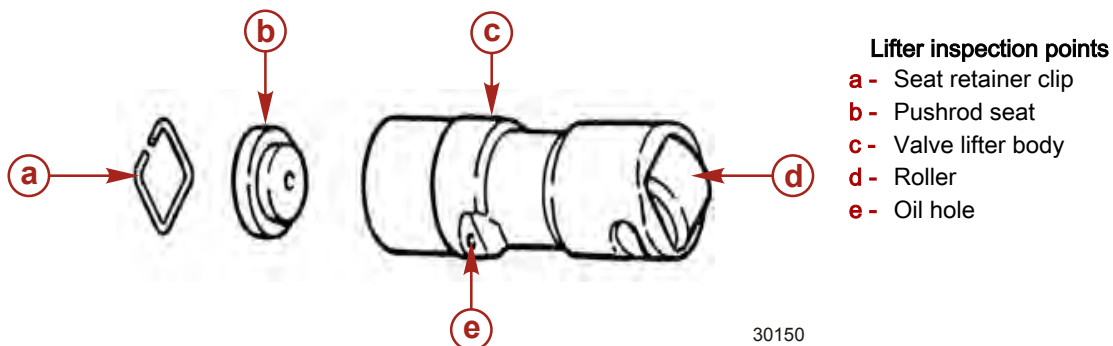


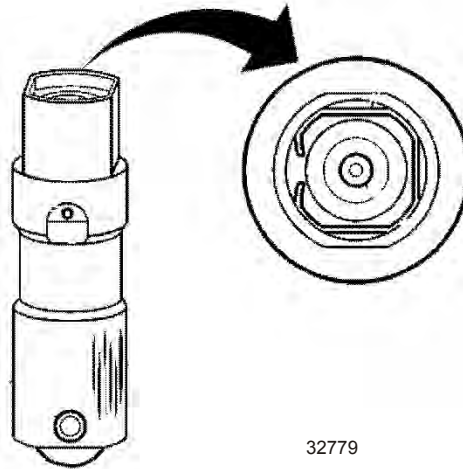
Cleaning

1. Except for the valve lifters, clean the parts with cleaning solvent.
2. Dry the parts with compressed air.
3. Keep the valve lifter upright, wipe with a clean, oil saturated, lint free cloth. Store the valve lifters in the upright position.

Inspection

1. Ensure that the lifter seat retainer clip is not broken or damaged.
2. Inspect the pushrod seat. If the seat is scuffed or worn, inspect the pushrod.
3. Inspect the outer lifter body wall. If the wall is scuffed or worn, inspect the engine block lifter bore.
4. Inspect the roller of the valve lifter. If the roller is scuffed or worn, inspect the camshaft lobe.
5. Ensure that the oil hole is unobstructed.
6. Inspect all parts carefully. Replace the valve lifter assembly that are damaged or excessively worn.





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7. Inspect the lifters for scoring or wear.

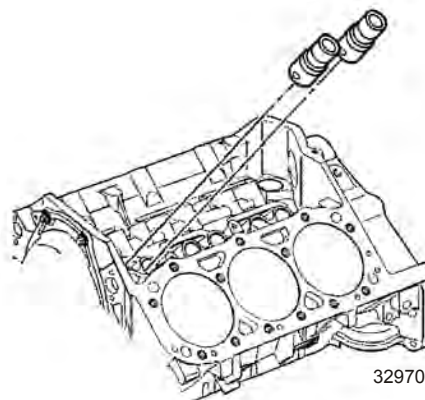
Installation

IMPORTANT: Do not install used valve lifters if a new camshaft has been installed.

IMPORTANT: Before installing the valve lifters, coat the camshaft lobes and valve lifters with engine assembly lubricant.

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Camshaft lobes and valve lifters	Obtain Locally

1. Lubricate and install the valve lifters. Install the valve lifters in their original locations if being reused.

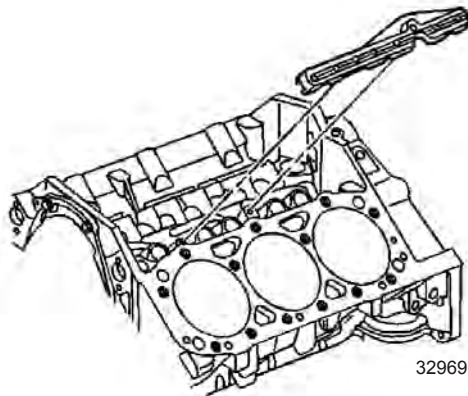


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Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Valve lifters	Obtain Locally

2. Install the lifter guides.

- 3. Install the lifter guide retainer. Tighten the bolts to the specified torque.



Description	Nm	lb-in.	lb-ft
Valve lifter guide retainer bolt	25	—	18

- 4. Lubricate and install the valve pushrods and rocker arm assemblies.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Valve pushrods and rocker arm assemblies	Obtain Locally

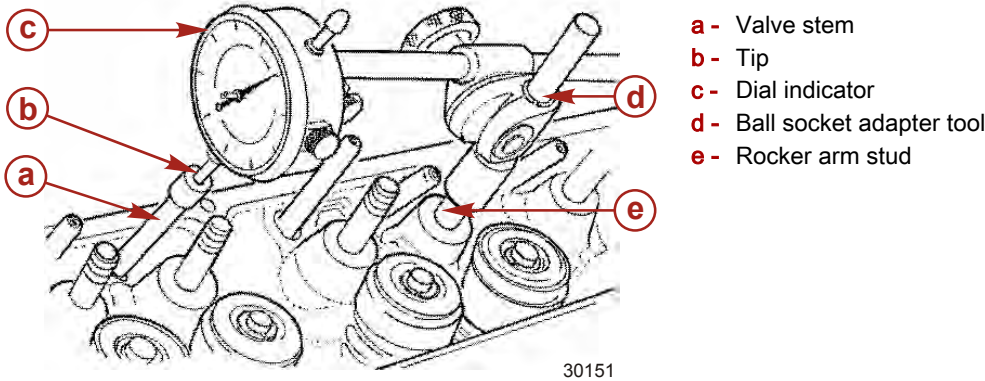
- 5. Install the intake manifold.
- 6. Install the valve covers.
- 7. Change the engine oil and filter.
- 8. Refill the closed cooling system, if equipped.
- 9. Check for leaks when the engine is started.

Camshaft, Camshaft Bearing, and Balance Shaft

Measuring Camshaft Lobe Lift

NOTE: This procedure is similar to checking valve timing. If improper valve operation is indicated, measure the lift of each valve pushrod in consecutive order, record the readings, and compare to specification.

- 1. Remove the rocker arm covers.
IMPORTANT: Keep the rocker arm assembly from each valve together as a matched set. Mark and organize parts so that they can be installed in the same location later.
- 2. Remove the rocker arm assemblies. Keep in matched sets.
- 3. Position the dial indicator with the ball socket adapter tool on the valve pushrod. Ensure that the valve pushrod is in the lifter socket.



Ball socket adapter tool	J8520-1
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4. Slowly rotate the crankshaft balancer in the direction of engine rotation until the lifter is on the heel of the camshaft lobe. At this point, the valve pushrod will be in its lowest position.
5. Set the dial indicator to 0°.
6. Slowly rotate the crankshaft balancer in the direction of engine rotation until the valve pushrod is in the fully raised position.
7. Compare the total lift recorded from dial indicator to specification.

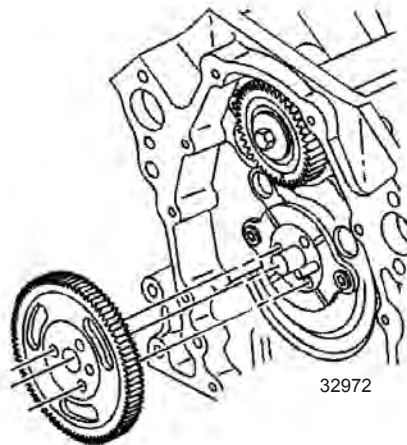
Description		4.3 Liter (262 cid)
Valve lift	Intake	10.527 mm (0.4140 in.) maximum
	Exhaust	10.879 mm (0.4280 in.)

8. Continue to rotate engine until dial indicator reads 0°. This will confirm the accuracy of the original reading.
9. Replace the camshaft if valve lift is not within specifications.
10. If the camshaft readings for all lobes are within specifications, remove the dial indicator assembly.
11. Install the rocker arm assemblies.
12. Adjust the valve clearance.
13. Install the rocker arm covers.
14. Start the engine and check for leaks.

Removal

Balance Shaft

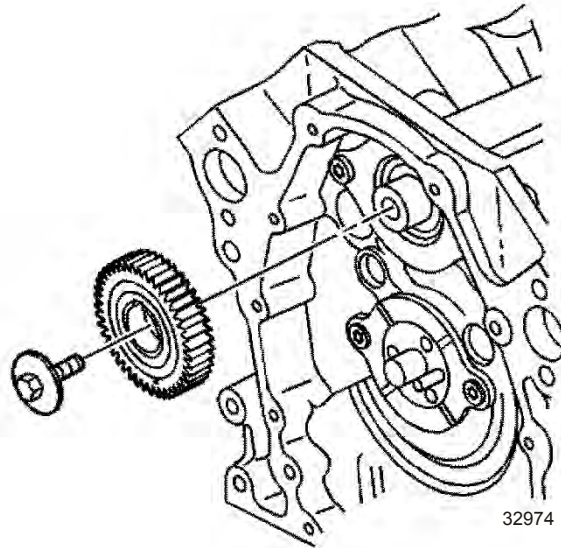
1. Remove the valve covers, rockers, pushrods, and intake manifold. Refer to **Intake Manifold Assembly**.
2. Remove the valve lifters.
3. Remove the crankcase front cover.
4. Remove the timing chain. Refer to **Timing Chain and Sprockets**.
5. Remove the balance shaft drive gear.



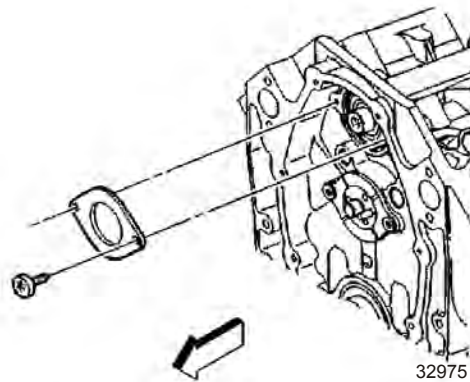
IMPORTANT: The balance shaft drive and balance shaft driven gears are serviced as a set. The set includes the balance shaft driven gear bolt.

6. Remove the balance shaft driven gear bolt from the balance shaft.
 - a. Place a wrench near the balance shaft front bearing to hold the balance shaft.
 - b. Remove the balance shaft bolt.
 - c. Remove the wrench.

7. Remove the balance shaft driven gear from the balance shaft.



8. Remove the bolts and the balance shaft retainer.

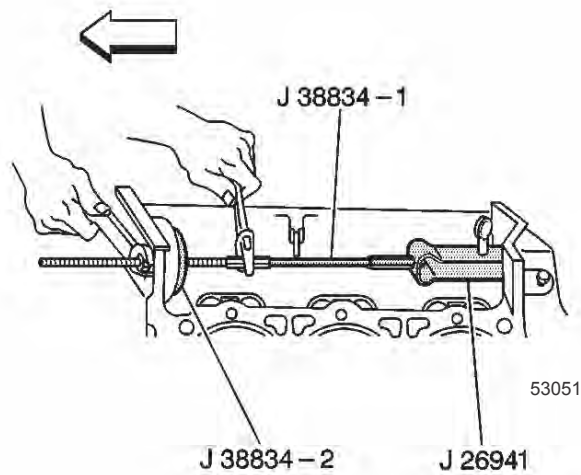


IMPORTANT: The balance shaft and the balance shaft front bearing are serviced only as a package. Do not remove the balance shaft front bearing from the balance shaft.

9. Use a soft-faced hammer in order to remove the balance shaft from the engine block.

Balance Shaft Bearing

1. Put on safety glasses.



Balance shaft service kit

2. Install the bushing/bearing remover legs behind the balance shaft rear bearing and secure.

Description	Part Number
Bushing/bearing remover	J26941

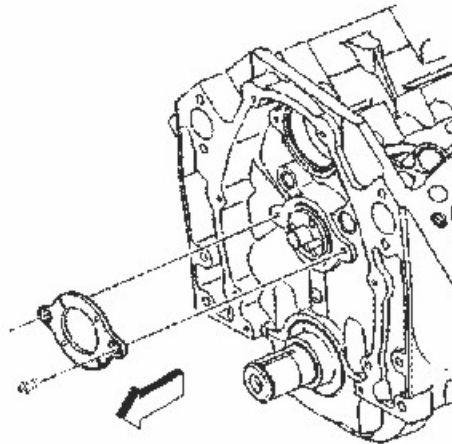
3. Install the short threaded end of the balance shaft service kit through the balance shaft bore in the front of the engine block.

Description	Part Number
Balance shaft service kit	J38834

4. Install the balance shaft service kit into the bushing/bearing remover.
5. Slide the J38834-2 onto J38834-1 and into the balance shaft bore.
6. Install the J38834 bearing, washer, and nut onto J38834-1.
7. Hold J38834-1 with a wrench and rotate the J38834 nut clockwise until the balance shaft rear bearing is removed.
8. Remove the bushing/bearing remover from the balance shaft rear bearing.
9. Discard the balance shaft rear bearing.

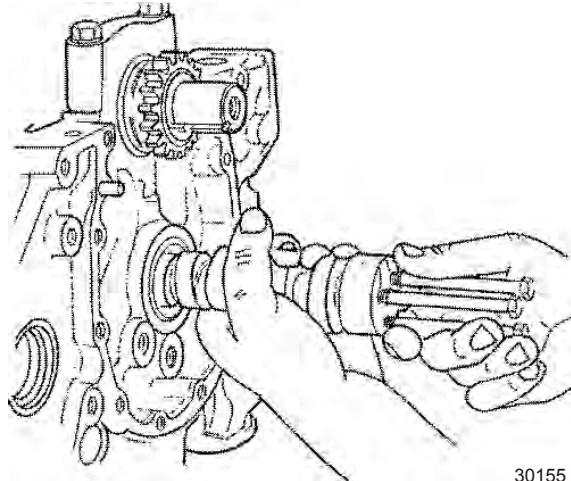
Camshaft Removal

1. Remove the camshaft thrust plate.



53506

2. Install three 5/16-18 x 5 in. long bolts in the camshaft bolt holes.
3. Carefully rotate and remove the camshaft as shown.



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Removing camshaft

Camshaft Bearing Service

IMPORTANT: Camshaft bearings can be replaced while the engine is disassembled for overhaul or without complete disassembly. To replace the bearings without complete disassembly, remove the camshaft and crankshaft. Leave the cylinder heads attached and the pistons in place. Disconnect and position the connecting rods against the outside of the cylinder walls so that they will not interfere with camshaft bearing replacement.

Cleaning

Balance Shaft

1. Put on safety glasses.
2. Clean the balance shaft, balance shaft retainer, balance shaft rear bearing, and balance shaft gears with cleaning solvent.
3. Dry all parts with compressed air.

Camshaft

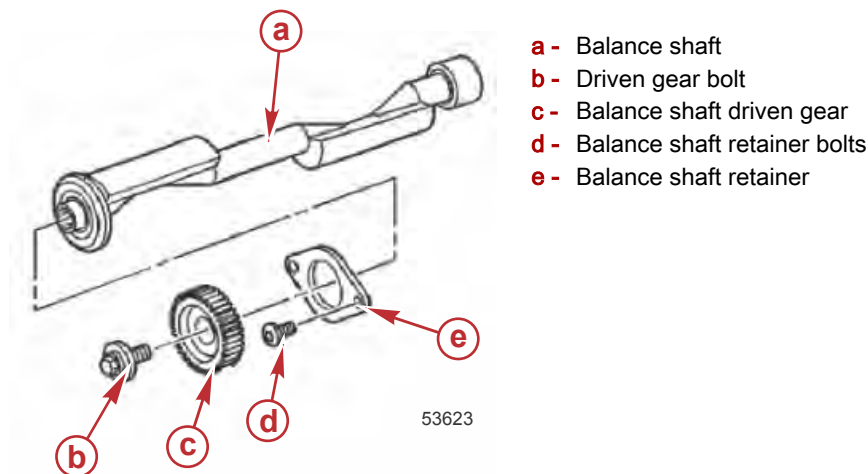
1. Put on safety glasses.
2. Clean the camshaft thrust plate with cleaning solvent.
3. Clean the camshaft with cleaning solvent.
4. Dry parts with compressed air.

Camshaft Bearings

1. Put on safety glasses.
2. Clean the bearings in cleaning solvent.
3. Clean the camshaft bearing bores in engine block with solvent.
4. Ensure that the grooves and drilled oil passages are clean.
5. Blow the bores and passages clean with compressed air.
6. Dry parts with compressed air.

Inspection

Balance Shaft



IMPORTANT: The balance shaft and the balance shaft front bearing are serviced only as an assembly. Do not remove the balance shaft front bearing from the balance shaft.

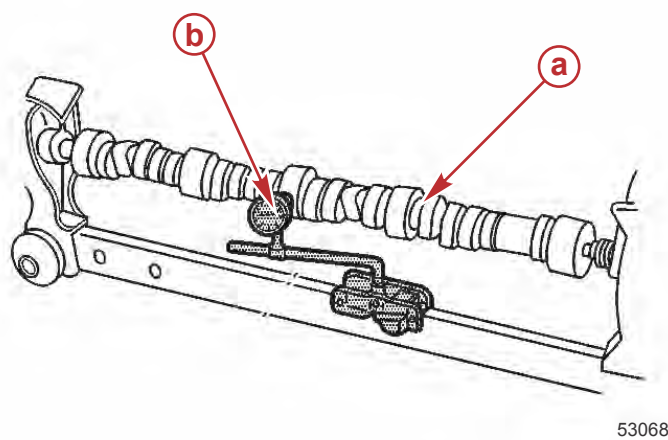
1. Inspect the front bearing for damage and smoothness of operation.
2. Inspect the rear bearing for damage.
3. Inspect the balance shaft, retainer, and gears for wear or damage.
4. Inspect the balance shaft journals for wear or damage.

Camshaft

1. Inspect the camshaft thrust plate for damage. Replace if damaged or worn.
2. Inspect the camshaft for worn, scored, or damaged bearing journals or lobes.
3. Inspect the camshaft for bolt hole threads.
4. Inspect the camshaft sprocket locator pin.
5. Measure the camshaft bearing journals with a micrometer. If journals are not within specifications, the camshaft should be replaced.

Description	4.3 Liter (262 cid)
Journal diameter	47.440–47.490 mm (1.8677–1.8697 in.)
Journal out of round	0.025 mm (0.0010 in.) maximum

6. Measure for a bent camshaft or excessive camshaft runout with a dial indicator. If the runout exceeds the specified amount, the camshaft should be replaced.



Checking camshaft runout
a - Camshaft
b - Dial indicator

Description	4.3 Liter (262 cid)
Camshaft runout	0.065 mm (0.0026 in.) maximum

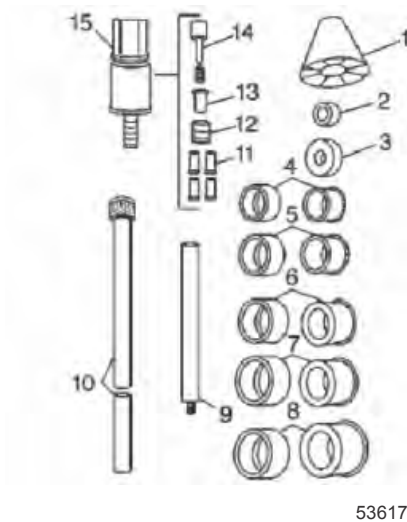
Bearings

- 1. Inspect camshaft bearings for excessive wear or scoring. If any camshaft bearing is excessively worn or scored, replace all the camshaft bearings.
- 2. Inspect the camshaft bearings for correct fit into the engine block camshaft bearing bores. The camshaft bearings have an interference fit to the engine block camshaft bearing bores and must not be loose in the bores.

Camshaft Bearings Removal

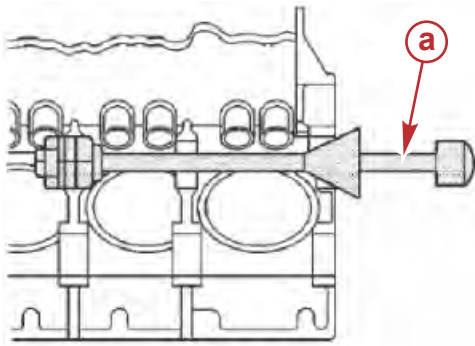
1. The camshaft bearing service kit is required to remove and install the camshaft bearing.

Description	Part Number
Camshaft bearing service kit	J33049



2. Select the cone (1), the handle (10), the expanding driver (4–8), the washer (2 or 3), and the expander assembly (15) from the service kit. Assemble the J33049.

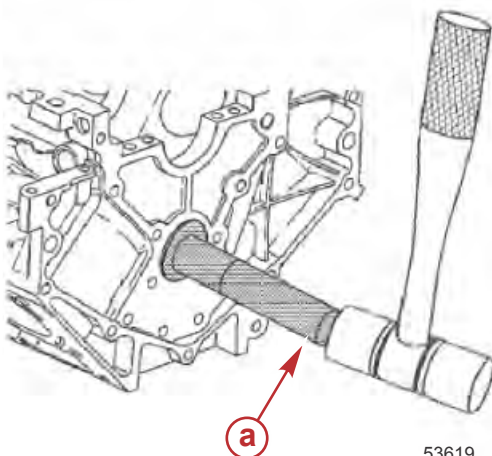
IMPORTANT: Always remove the camshaft inner bearings #2 and #3 first. The camshaft outer bearing #1 and #4 serve as a guide for the J33049.



53618

a - Camshaft bearing tool assembled (J33049)

3. Remove the camshaft inner bearing #2 and #3.
 - a. Insert the J33049 through the front of the engine block and into the camshaft inner bearing #2.
 - b. Tighten the J33049 expander assembly nut until snug.
 - c. Push the J33049 guide cone into the camshaft front bearing in order to align the J33049.
 - d. Drive the camshaft inner bearing #2 from the camshaft inner bearing bore #2.
 - e. Loosen the J33049 expander assembly nut.
 - f. Remove the camshaft inner bearing #2 from the J33049 expander assembly.
 - g. Insert the J33049 expander assembly into the camshaft inner bearing #3.
 - h. Tighten the J33049 expander assembly nut until snug.
 - i. Push the J33049 guide cone into the camshaft front bearing in order to align the J33049.
 - j. Drive the camshaft inner bearing #3 from the camshaft inner bearing bore #3.
 - k. Loosen the J33049 expander assembly nut.
 - l. Remove the camshaft inner bearing #3 from the J33049 expander assembly.
4. Remove the J33049 from the engine block.
5. Remove the camshaft outer bearings #1 and #4.
 - a. Insert the J33049 into the camshaft outer bearing #1.
 - b. Tighten the J33049 expander assembly nut until snug.
 - c. Drive the camshaft outer bearing #1 from the camshaft outer bearing bore #1.
 - d. Loosen the J33049 expander assembly nut.
 - e. Remove the camshaft outer bearing #1 from the J33049 expander assembly.
 - f. Remove the J33049 from the engine block.
 - g. Insert the J33049 expander assembly into the camshaft outer bearing #4.
 - h. Tighten the J33049 expander assembly nut until snug.



53619

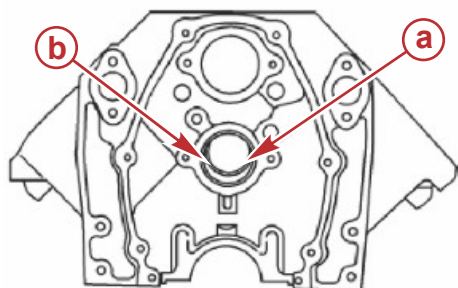
a - Camshaft bearing service kit driver (J33049)

- i. Drive the camshaft outer bearing #4 from the camshaft outer bearing bore #4.

- j. Loosen the J33049 expander assembly nut.
 - k. Remove the camshaft outer bearing #4 from the J33049 expander assembly.
6. Remove the J33049 from the engine block.
 7. Discard the camshaft bearings.

Camshaft Bearing Installation

IMPORTANT: When installing the camshaft bearings, always look in order to ensure that the camshaft bearing lubrication hole is located above the 3 o'clock position or the 9 o'clock position. The proper positioning of the camshaft bearing lubrication hole is in order to ensure the best lubrication of the engine camshaft journals.

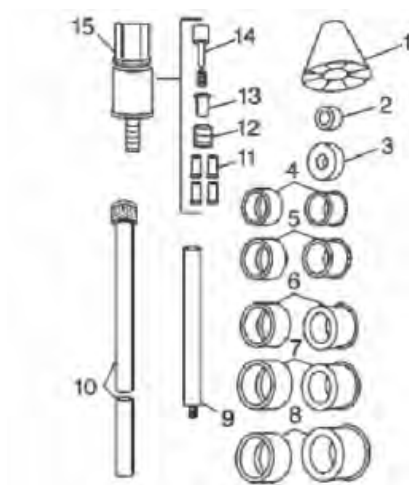


53620

a - 3 o'clock position

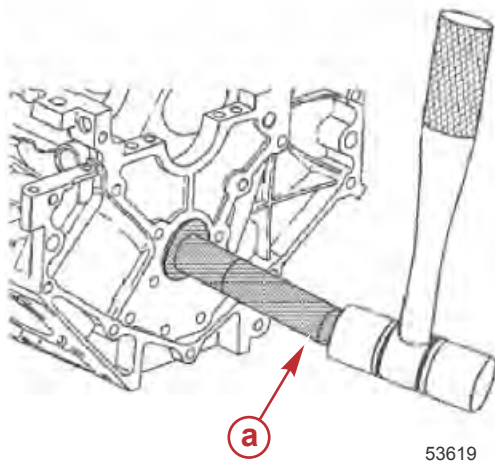
b - 9 o'clock position

1. Select the handle (10), the expanding driver (4–8), the washer (2 or 3), and the expander assembly (15) from the J33049.
2. Assemble the J33049.



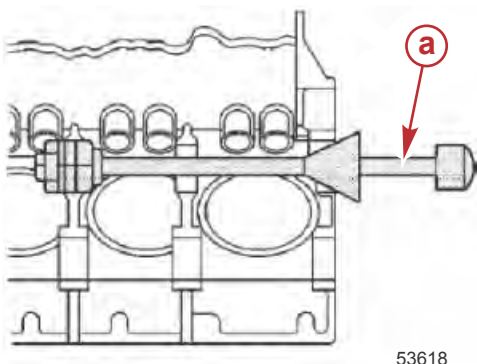
53617

IMPORTANT: The camshaft bearings vary in size. When ordering the new camshaft bearings, be sure to order the correct camshaft bearings for the application to be serviced. Always install the camshaft outer bearings #1 and #4 first. The camshaft outer bearings serve as a guide for the J33049 and help center the camshaft inner bearings during the installation process.



a - Camshaft bearing service kit driver (J33049)

3. Install the new camshaft outer bearings #4 and #1.
 - a. Install the new camshaft outer bearing #4 onto the J33049 expander assembly.
 - b. Tighten the J33049 expander assembly nut until snug.
 - c. Align the lubrication hole of the camshaft outer bearing #4 above the 3 o'clock position or the 9 o'clock position of the camshaft outer bearing bore #4 at the rear of the engine block.
 - d. Drive the camshaft outer bearing #4 into the camshaft outer bearing bore #4 at the rear of the engine block.
 - e. Loosen the J33049 expander assembly nut.
 - f. Remove the camshaft outer bearing #4 from the J33049 expander assembly.
 - g. Install the camshaft outer bearing #1 onto the J33049 expander assembly.
 - h. Tighten the J33049 expander assembly nut until snug.
 - i. Align the lubrication hole of the camshaft outer bearing #1 above the 3 o'clock position or the 9 o'clock position of the camshaft outer bearing bore #1 at the front of the engine block.
 - j. Drive the camshaft outer bearing #1 into the camshaft outer bearing bore #1 at the front of the engine block.
 - k. Loosen the J33049 expander assembly nut.
 - l. Carefully slide the J33049 into the engine block until the J33049 expander assembly is positioned between the camshaft inner bearing bores.
4. Install the camshaft inner bearings #3 and #2.

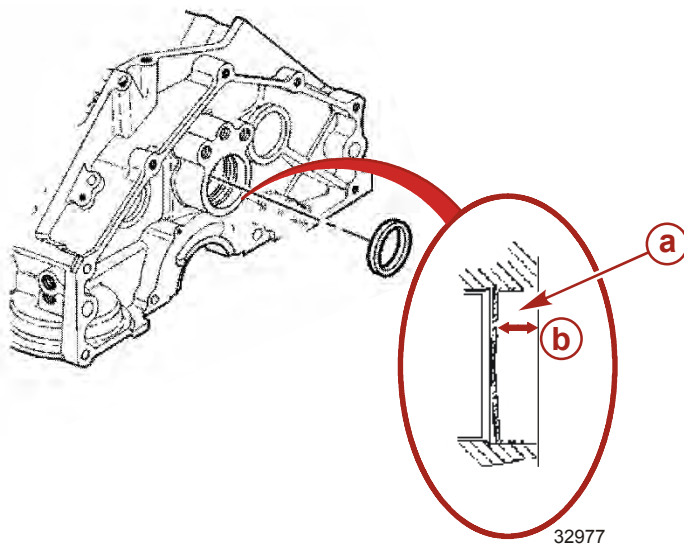


a - Camshaft bearing tool assembled (J33049)

- a. Install the camshaft inner bearing #3 onto the J33049 expander assembly.
- b. Tighten the J33049 expander assembly nut until snug.
- c. Align the lubrication hole of the camshaft inner bearing #3 above the 3 o'clock position or the 9 o'clock position of the camshaft inner bearing bore #3 of the engine block.
- d. Push the J33049 guide cone into the camshaft front bearing bore #1 in order to align the J33049.
- e. Drive the camshaft inner bearing #3 into the camshaft inner bearing bore #3 of the engine block.

- f. Loosen the J33049 expander assembly nut.
 - g. Carefully slide the J33049 until the J33049 expander assembly is positioned between the camshaft inner bearing bore #2 and the camshaft outer bearing bore #1.
 - h. Install the new camshaft inner bearing #2 onto the J33049 expander assembly.
 - i. Tighten the J33049 expander assembly nut until snug.
 - j. Align the lubrication hole of the camshaft inner bearing #2 above the 3 o'clock position or the 9 o'clock position of the camshaft inner bearing bore #2 of the engine block.
 - k. Push the J33049 guide cone into the camshaft front bearing bore #1 in order to align the J33049.
 - l. Drive the camshaft inner bearing #2 into the camshaft inner bearing bore #2 of the engine block.
 - m. Loosen the J33049 expander assembly nut.
5. Carefully remove the J33049 from the engine block.
 6. Coat the outer diameter of a new camshaft rear bearing hole expansion cup plug with sealant.
 7. Install a new camshaft rear bearing hole expansion plug.

IMPORTANT: The camshaft rear bearing hole plug must be installed 8.8 mm (0.35 in.) deep and must be parallel with the rear surface of the engine block.



- a** - Camshaft rear bearing hole expansion cup plug
b - Measurement—8.8 mm (0.35 in.)

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Expansion cup plug (camshaft rear bearing hole)	Obtain Locally

Installation

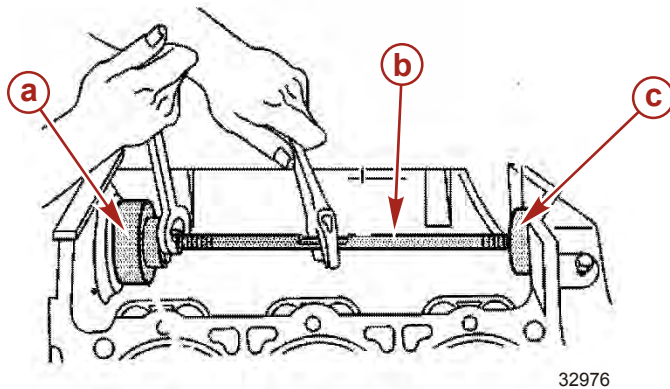
Balance Shaft Bearing

1. Install J38834-3 from the balance shaft service kit (J38834) onto the short threaded end of the rod (J38834-1).
2. Install the nut, the washer, and the bearing from the balance shaft service kit (J38834) onto the long threaded end of the rod (J38834-1).
3. Install J38834-2 from the balance shaft service kit (J38834) onto the rod (J38834-1) so that the smaller diameter of J38834-2 will be facing the front of the engine block.
4. Install J38834-2 on the inside of the balance shaft front bearing bore.
5. Lubricate the new balance shaft rear bearing.

Tube Ref No.	Description	Where Used	Part No.
	SAE Engine Oil 30W	Balance shaft bearings	Obtain Locally

6. Install the balance shaft rear bearing onto J38834-2.
7. Align the bearing for installation.
8. Using a wrench, secure the rod (J38834-1).

9. Rotate the nut until the balance shaft bearing is completely pushed into the balance shaft rear bearing bore.



- a - Balance shaft service kit (J38834-2)
b - Rod (J38834-1)
c - Balance shaft service kit (J38834-3)

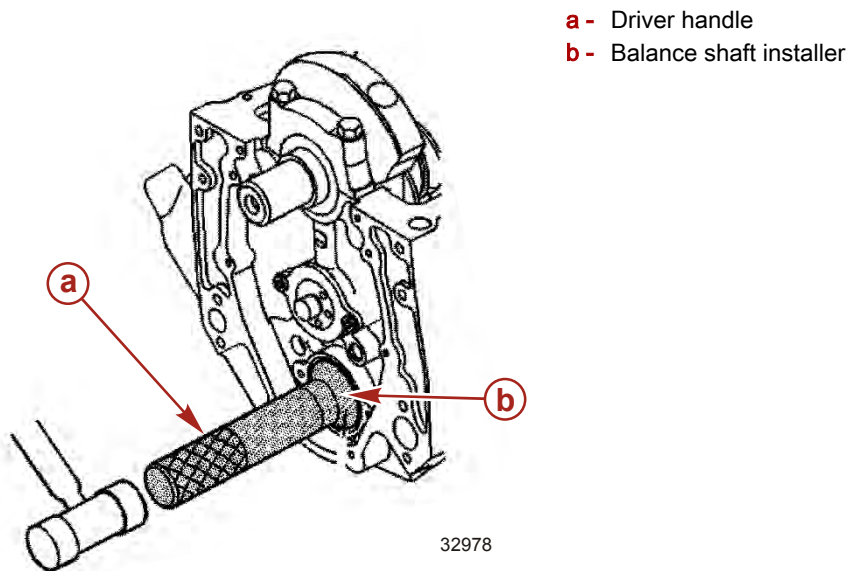
10. Remove the tool.

Balance Shaft

1. Lubricate the balance shaft front bearing.

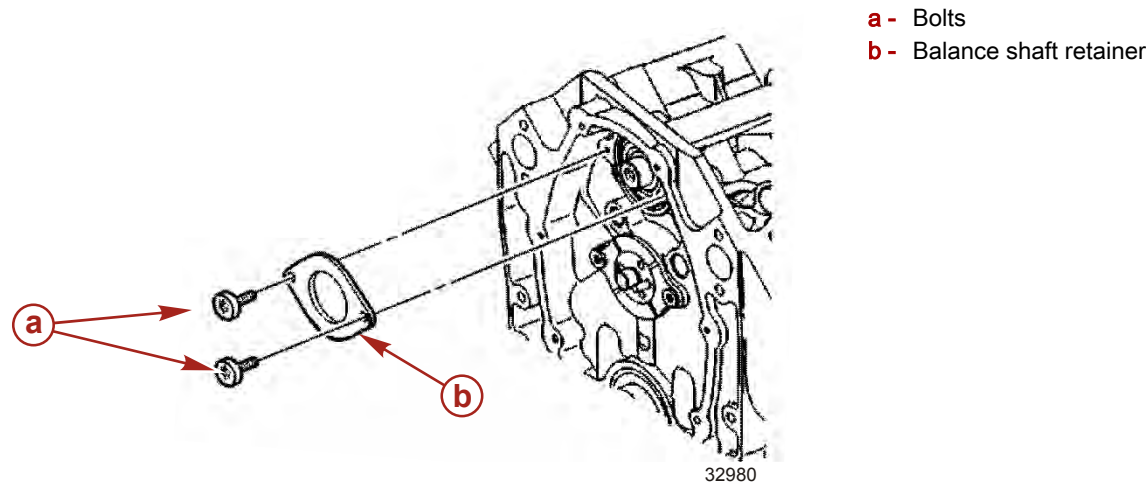
Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Balance shaft front bearing	Obtain Locally

2. Using the balance shaft installer and the driver handle install the balance shaft.



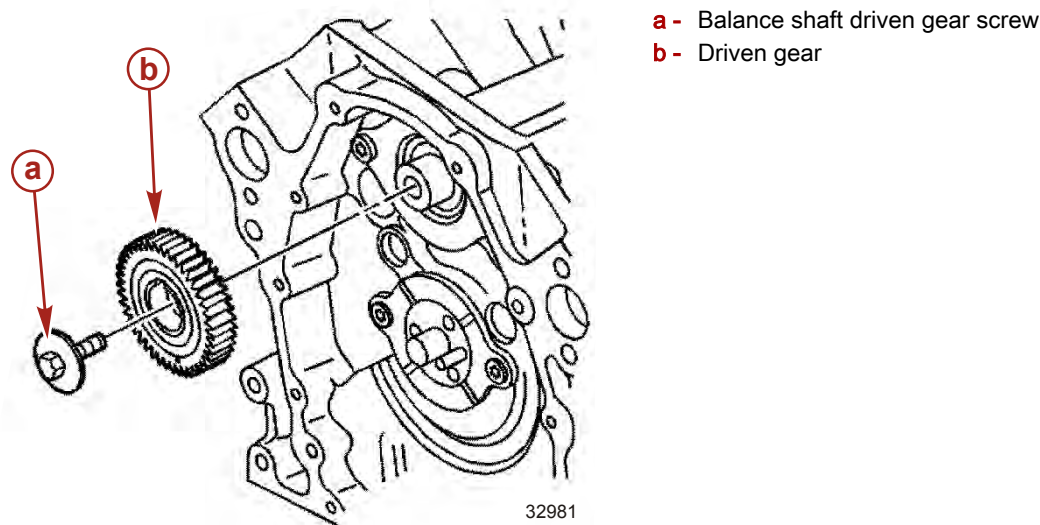
3. Install the balance shaft retainer and bolts.

4. Tighten the bolts to the specified torque.



Description	Nm	lb-in.	lb-ft
Balance shaft retainer bolts	12	106	–

5. Install the balance shaft driven gear onto the balance shaft.
6. Apply adhesive to the threads of the balance shaft driven gear screw.



Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Balance shaft driven gear screw threads	92-809821

7. Install the balance shaft driven gear screw, as follows:
- a. Secure the balance shaft with a wrench.
 - b. Install and tighten the balance shaft driven gear screw to the specified torque.

Description		Nm	lb-in.	lb-ft
Balance shaft drive gear screws	First	20	177	–
	Final	+35°		

8. Remove the wrench from the balance shaft.

9. Rotate the balance by hand to ensure clearance between the balance shaft and the valve lifter pushrod guide.

NOTE: If the balance shaft does not rotate freely, ensure the retaining ring on the balance shaft front bearing is seated on the case.

Camshaft

1. Install three 5/16-18 x 5 in. bolts into the camshaft bolt holes.
2. Lubricate the camshaft journals with engine oil and install the camshaft. Be careful not to damage the bearings.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE engine oil 30W	Camshaft journals	Obtain Locally

3. Lubricate the camshaft lobes with Johnson EP Lube or equivalent.

Tube Ref No.	Description	Where Used	Part No.
	Johnson EP Lube Part Number 92-801779	Camshafts and camshafts lobes	Obtain Locally

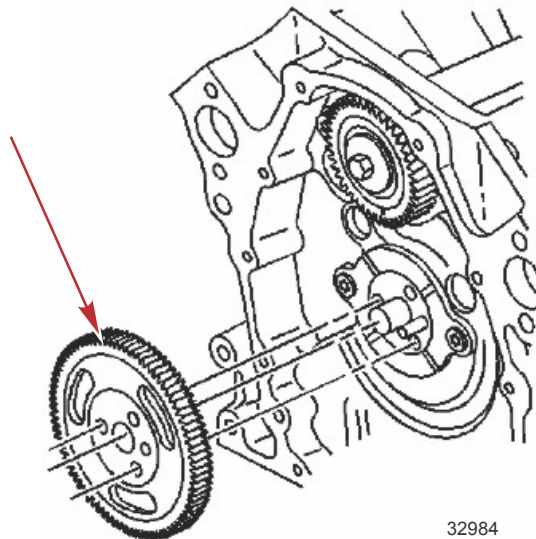
4. Remove the three bolts in the camshaft bolt holes.
5. Coat the threads of the camshaft thrust plate retainer bolts with adhesive.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Camshaft thrust plate retainer bolt threads	92-809821

6. Install the camshaft thrust plate retainer and bolts. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Camshaft thrust plate (retainer) bolts	12	106	—

7. Install the balance shaft drive gear.

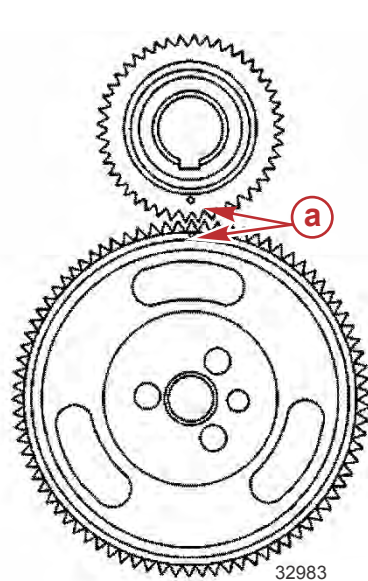


32984

Balance shaft drive gear

8. Rotate the engine camshaft so that the timing mark on the balance shaft drive gear is in the 12 o'clock position.
9. Remove the balance shaft driven gear.
10. Rotate the balance shaft so that the timing mark on the balance shaft driven gear is in the 6 o'clock position.
11. Position the balance shaft driven gear onto the engine camshaft.

12. Ensure that the balance shaft drive gear and the balance shaft driven gear timing marks are aligned.



a - Timing marks

13. Install the camshaft sprocket and timing chain. Refer to **Timing Chain and Sprockets**.
14. Install the valve lifters.

Description	Nm	lb-in.	lb-ft
Lifter guide bolts	16	142	–

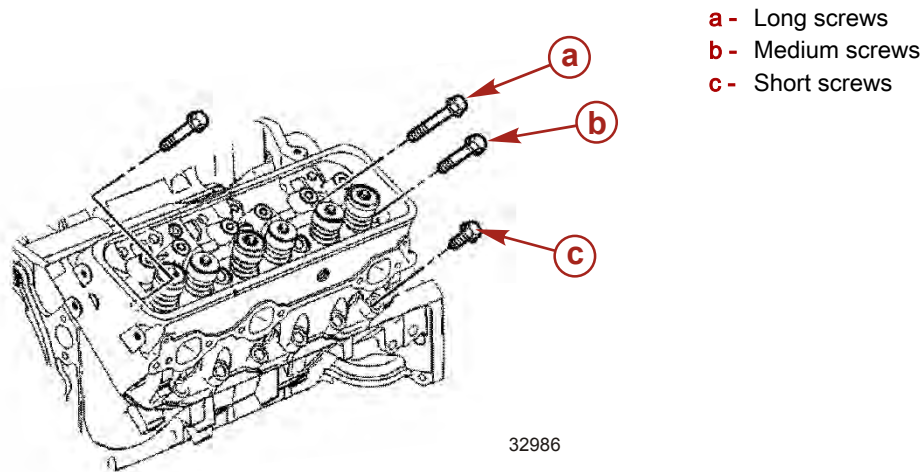
15. Install valve covers, rockers, push rods, and intake manifold. Refer to **Intake Manifold Assembly**.

Cylinder Head

Removal

1. Drain the seawater and closed cooling systems.
2. Remove the exhaust elbows and manifolds.
3. Remove any other external components that might interfere with access to the cylinder heads (these will vary by application).
4. Remove the rocker arm covers.
5. Remove the intake manifold assembly. Refer to **Intake Manifold Assembly**.
IMPORTANT: Keep the rocker arm assemblies, valve pushrods, and hydraulic valve lifters from each valve together as a matched set. Mark and organize parts so that they can be reinstalled in the same location later.
6. Remove the rocker arm assemblies and valve pushrods. Keep in matched sets.
7. Remove the spark plugs.

8. Remove the cylinder head screws.



9. Remove the cylinder head.
 10. Place the cylinder head on wooden blocks, a rubber mat, or other material that will prevent damage to the gasket surfaces.
 11. Repeat this process for the second cylinder head.

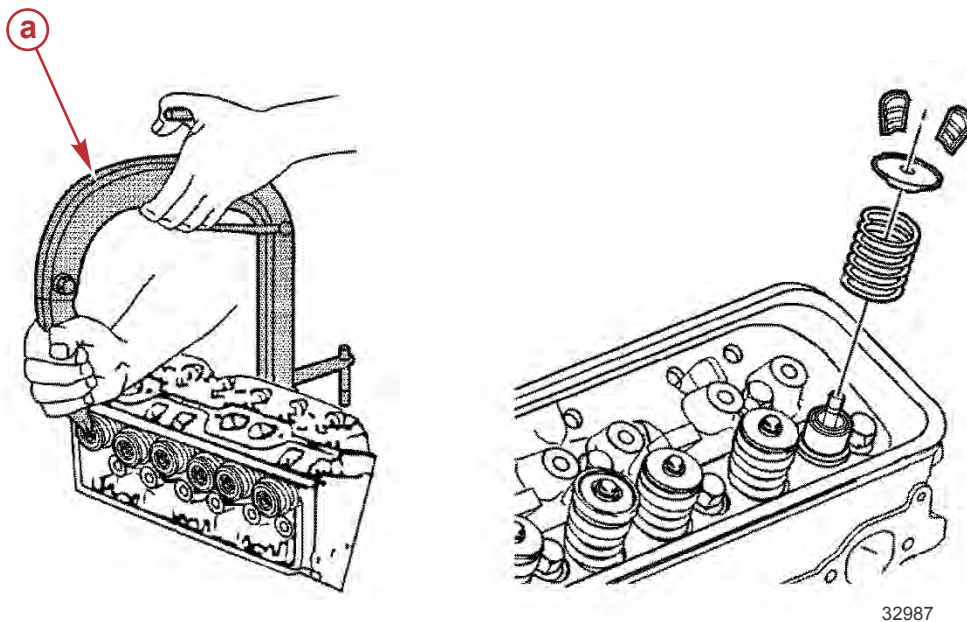
Disassembly

1. Using the valve spring compressor, compress the valve spring, and remove the valve locks. Slowly release the tool. Keep components together as a matched set. Mark and organize the parts so that they can be installed in the same location later.

Description	Part Number
Valve spring compressor	J8062

IMPORTANT: Keep components together as a matched set. Mark and organize parts so that they can be installed in the same location later.

2. Remove valve cap and spring.

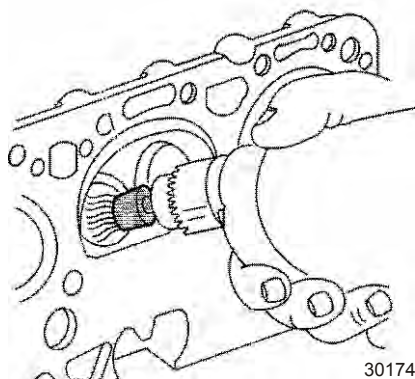


- a** - Valve spring compressor (J8062)

3. Remove the valves from the cylinder head.
4. Mark and organize components for installation in the same location later.
5. Remove and discard the valve stem oil seals.
6. Place the cylinder head on wooden blocks to prevent damage to the gasket surfaces.

Cylinder Head Cleaning

1. Clean all gasket material and sealant from the engine block, cylinder, intake manifold, and exhaust manifold head sealing surfaces.
2. Clean all the carbon from the combustion chambers and the intake and exhaust ports using a carbon cleaning brush.



Carbon cleaning brush

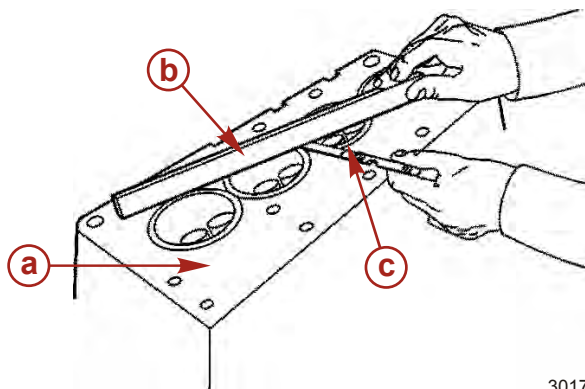
Description	Part Number
Kent moore carbon cleaning brush	J8089

3. Clean all cylinder head and engine block bolt hole threads.
4. Clean the surface of the cylinder head with solvent.
5. Dry the cylinder head, including the cylinder head and engine block bolt hole threads with compressed air.

Inspection

Cylinder Head

1. Inspect the sealing surfaces for burrs, scratches, deep nicks, erosion, or other damage.
2. Inspect for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats).
3. Replace the cylinder heads if necessary.
4. Inspect for rusted, damaged, or leaking core plugs. Replace core plugs if necessary.
5. Inspect for corrosion around cooling passages.
6. Check the flatness of cylinder head gasket surfaces (head, exhaust, and intake gaskets) using a machinist's straight edge and feeler gauges. Take measurements diagonally across the cylinder head from all four corners and straight down the center of the cylinder head lengthwise.



Head deck shown, exhaust and intake decks are similar

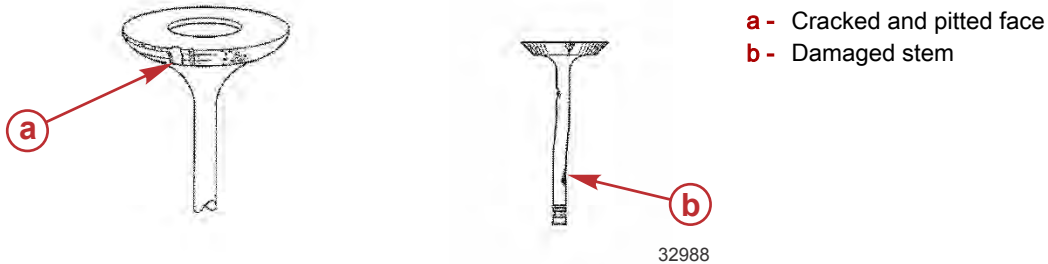
- a - Cylinder head deck
- b - Machinist's straight edge
- c - Feeler gauge

Description		4.3 Liter (262 cid)
Surface flatness	Exhaust manifold deck	0.05 mm (0.002 in.)
	Head deck (within a 152 mm [6.0 in.] area)	0.10 mm (0.004 in.)
	Intake manifold deck	0.10 mm (0.004 in.)
	Intake manifold flatness	0.10 mm (0.004 in.)

7. If a measured value is greater than specified, the cylinder head must be repaired to specifications or replaced.

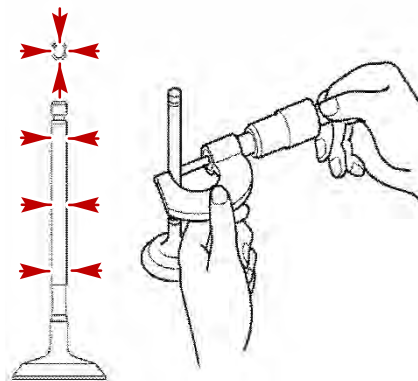
Valve

1. Inspect the valves for burned heads, cracked or pitted faces, or damaged stems.



IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possibly broken valves. Insufficient clearance will result in noisy, binding valves.

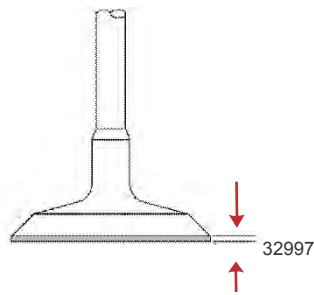
2. Measure the valve stem diameter in three places.
3. If the measured value is less than the specified limit, the valve must be replaced.



Description		4.3 Liter (262 cid)
Production stem diameter	Intake	8.661–8.679 mm (0.3410–0.3417 in.)
	Exhaust	
Service stem oversize diameter	Exhaust only	+0.774 mm (+0.0305 in.)

4. Measure the valve head margin.

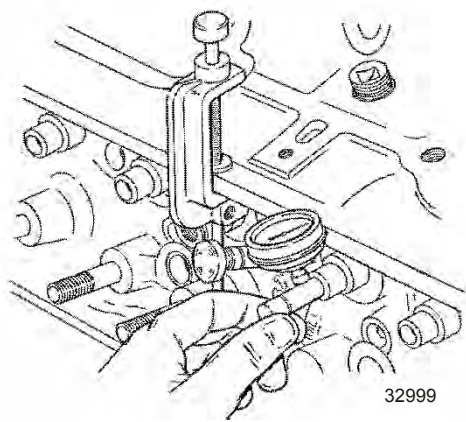
5. If measured value is less than specified, the valve must be replaced.



Description		4.3 Liter (262 cid)
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum

Valve Stem to Bore Clearance

1. Using a valve with a specified stem diameter or a new valve, measure valve stem clearance.
2. Attach a dial indicator to the cylinder head. Position it against the valve stem and close to the valve guide.
3. Holding the valve head off the seat about 2 mm (1/16 in.), move the valve stem side to side in the guide as shown. Compare the stem clearance with the specifications.



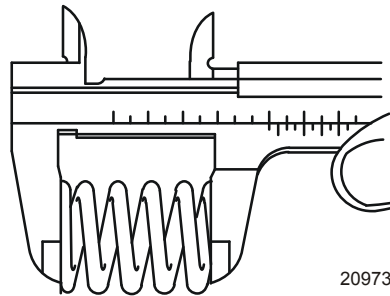
Measuring stem clearance

Description		4.3 Liter (262 cid)
Production	Intake	0.025–0.069 mm (0.0010–0.0027 in.)
	Exhaust	0.025–0.069 mm (0.0010–0.0027 in.)
Service	Intake	0.025–0.094 mm (0.0010–0.0037 in.)
	Exhaust	0.025–0.094 mm (0.0010–0.0037 in.)

4. If the clearance exceeds specifications on the exhaust valve and exhaust guide: it is necessary to ream the valve guide and install a valve with an oversized stem. Refer to **Repair—Valve Guide Bore**.
5. If the clearance exceeds specifications on the intake valve and intake guide: it is necessary to replace the cylinder head. Intake valves are not available with oversize stems.

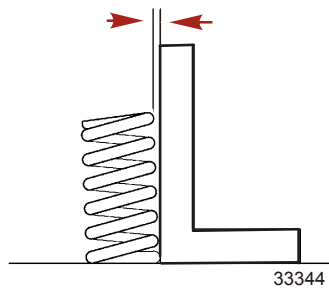
Valve Springs

1. Use a vernier caliper to measure the valve spring free length. Replace the spring if it is more or less than the specified limit.

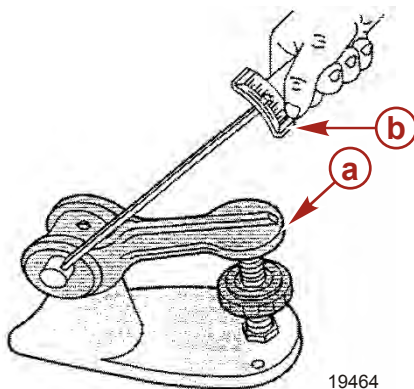


Description	4.3 Liter (262 cid)
Free length	51.3 mm (2.02 in.)

2. Measure the valve for squareness.



3. Use a spring compressor to measure the valve spring tension. Replace the spring if the measured value is less than the specified limit.



- a** - Valve spring compressor (J9666)
b - Torque wrench

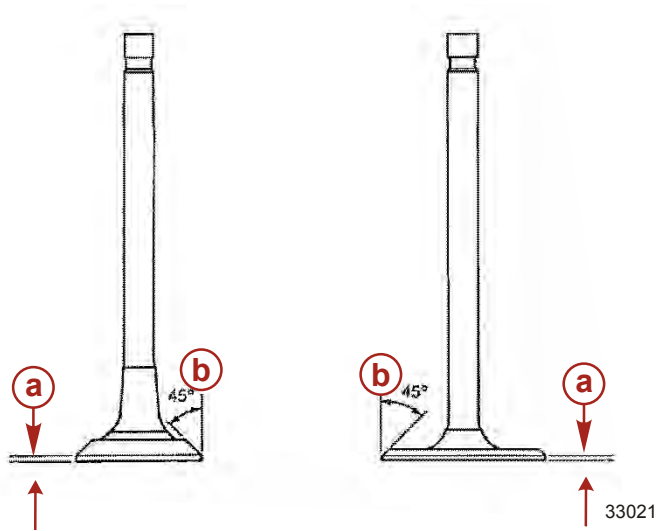
Description	Part Number
Valve spring compressor	J9666

Description	4.3 Liter (262 cid)	
Force	Valve closed	338–374 N (76–84 lb) at 43.2 mm (1.7008 in.)
	Valve open	832–903 N (187–203 lb) at 32.3 mm (1.2717 in.)

Repair

Valve Reconditioning

- 1. Recondition the valve face to the proper angle if the valve face is pitted or worn.
 - 2. Measure the valve margin. If the valve margin is less than the specified amount after reconditioning, replace the valve.
- NOTE:** Several different types of equipment are available for reconditioning valves. The manufacturer's recommendation should be carefully followed to attain proper results.



Exhaust

Intake

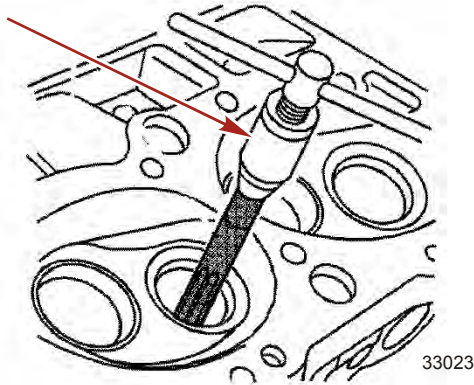
- a - Margin
- b - Face angle

Description		4.3 Liter (262 cid)
Face angle	Intake	45°
	Exhaust	45°
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum

Valve Guide Bore

IMPORTANT: Measure the valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

1. If exhaust valves with oversize valve stems are required, ream valve guide bores.



Valve guide reamer (J5830-3)

Description	Part Number
Valve guide reamer	NLA

Description	4.3 Liter (262 cid)	
Production stem diameter	Intake	8.661–8.679 mm (0.3410–0.3417 in.)
	Exhaust	
Service stem oversize diameter	Exhaust only	+0.774 mm (+0.0305 in.)

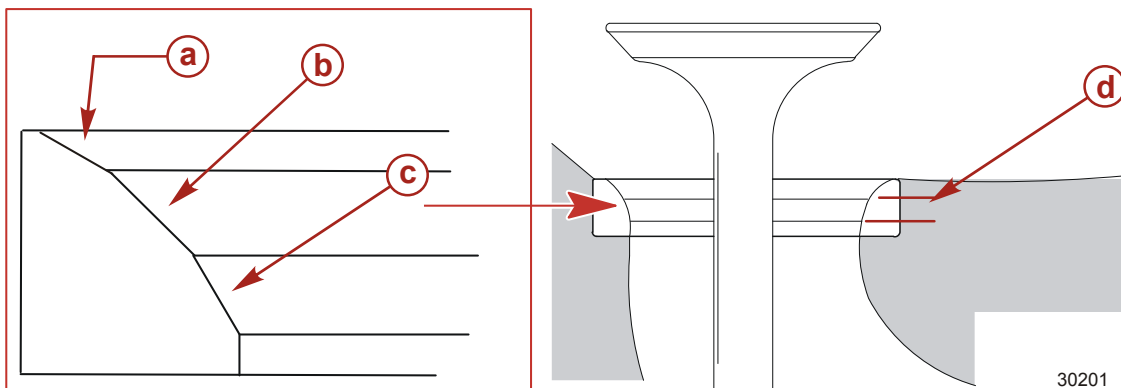
2. Remove the sharp corner created by the reamer at the top of the valve guide.
3. Install the valve with the oversized stem.
4. Measure the valve stem to bore clearance.

Valve Seat

IMPORTANT: Regardless of the type of equipment, it is essential that the valve guide bores be free from carbon or dirt to achieve proper centering of the pilot in the valve guide, ensuring concentricity when reconditioning the valve seats.

NOTE: Several different types of equipment are available for reconditioning valve seats. Equipment manufacturer's recommendations should be followed to attain proper results.

1. Recondition the valve seats if pitted or worn.

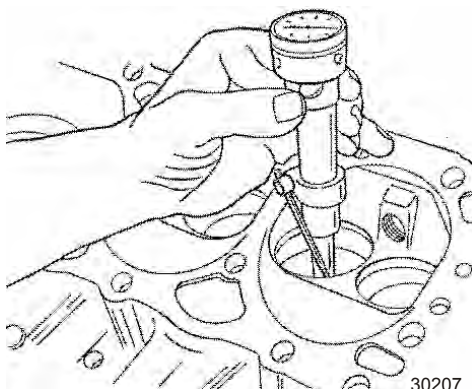


Typical 3 angle valve seat

- a** - Top correction cut angle
- b** - Seat angle
- c** - Bottom correction cut angle
- d** - Seat width

Description		4.3 Liter (262 cid)
Seat angle	Intake and exhaust	46°
Top correction cut angle		30°
Bottom correction cut angle		60°
Width	Intake	1.016–1.651 mm (0.040–0.065 in.)
	Exhaust	1.65–2.489 mm (0.0650–0.0980 in.)

2. Measure the valve seat concentricity.
3. Recondition the seat if measured value exceeds specified limit.



Measuring valve seat concentricity

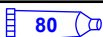
Description		4.3 Liter (262 cid)
Width	Intake	0.05 mm (0.0020 in.) maximum
	Exhaust	

Cylinder Head Reassembly

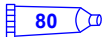
IMPORTANT: Install each valve in the port from which it was removed or for which it has been fitted.

IMPORTANT: Intake valve stem oil seals are black. Exhaust valve stem oil seals are red or they are brown with a white paint stripe on the outer diameter. The letters "EX" are molded into the top of exhaust valve stem oil seals.

1. Assemble a valve into its proper port and valve guide. Apply clean engine oil to the valve stem.

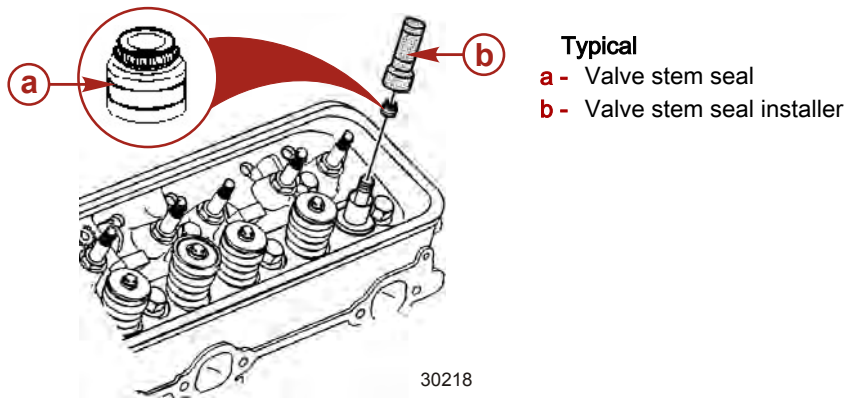
Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Valve stem	Obtain Locally

2. Select the appropriate intake or exhaust valve stem oil seal.
3. Coat the outside surface of the valve stem bore and all surfaces of the valve stem oil seal with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Outside surface of valve stem bore and all surfaces of the valve stem oil seal	Obtain Locally

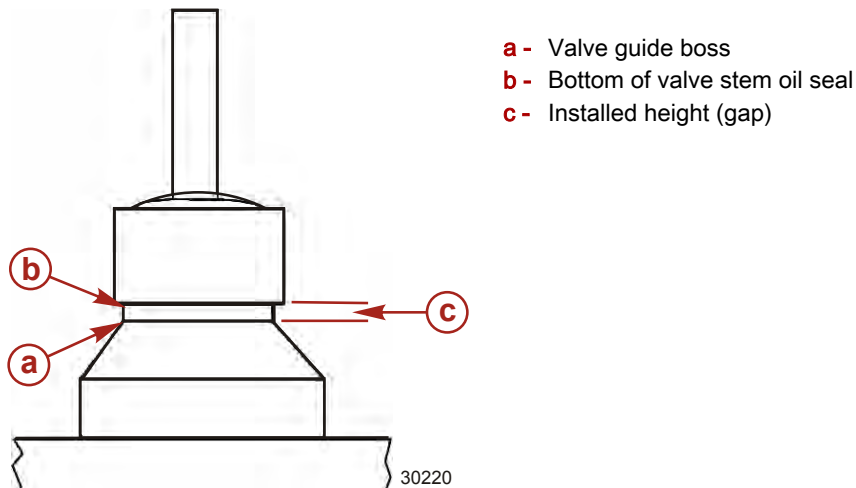
4. Assemble the valve stem oil seal onto the valve stem and slide down until it contacts the valve spring seat.

5. Press the valve stem oil seal with the valve stem seal installer until the tool contacts the spring seat.



Description	Part Number
Kent-Moore valve stem seal installer	J42073

6. For all intake and exhaust valves, ensure that the installed height (the gap between the bottom edge of the valve stem oil seal and the cylinder head valve guide boss) is as specified.



Description	4.3 Liter (262 cid)	
Valve stem oil seal	Installed height NOTE: Measured from top of valve guide bevel to bottom of oil stem seal.	1–2 mm (0.0394–0.0787 in.) minimum

7. Install the valve spring.
 8. Place a valve spring cap on the valve spring.

⚠ CAUTION

Improperly compressed springs or improperly locked valve caps could allow the spring to be ejected with tremendous force, which could cause personal injury. Use care when compressing the valve springs or releasing the valve spring compressor tool.

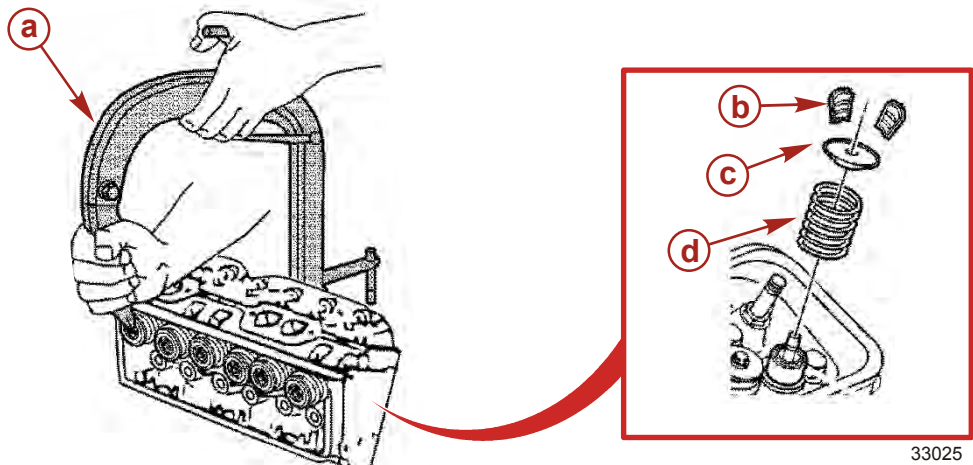
9. Compress the valve spring using a valve spring compressor.

Description	Part Number
Valve spring compressor	J8062

10. Coat the valve stem locks with lubricant to hold in place.

Tube Ref No.	Description	Where Used	Part No.
 4	Needle Bearing Assembly Lubricant	Valve stem locks	8M0071836

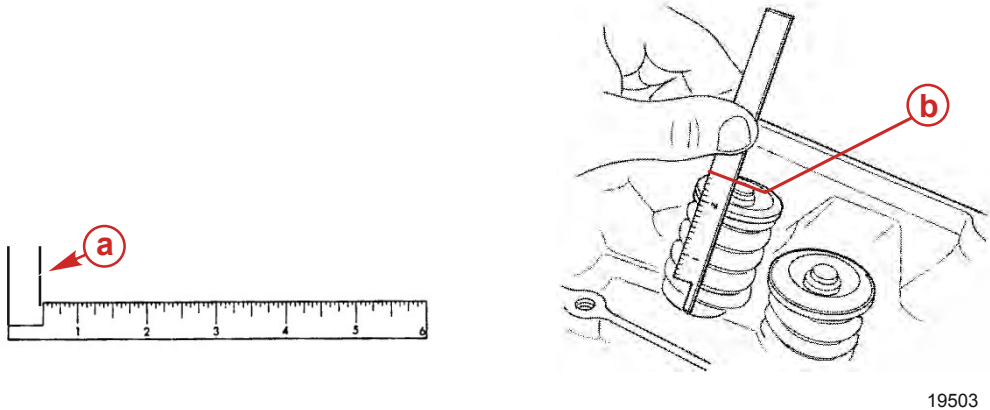
- 11. Install the valve stem locks.
- 12. Confirm that the valve stem locks are properly seated in the grooves of the valve stem.



- a - Valve spring compressor
- b - Valve locks
- c - Valve cap
- d - Valve spring

- 13. Slowly release the valve spring compressor.
- 14. Set the assembly by tapping the valve stem with a soft plastic hammer.
- 15. Check the installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring.
IMPORTANT: If measurement exceeds specified height, install a valve spring shim and recheck. Do not shim valve springs to give an installed height less than the minimum specified.

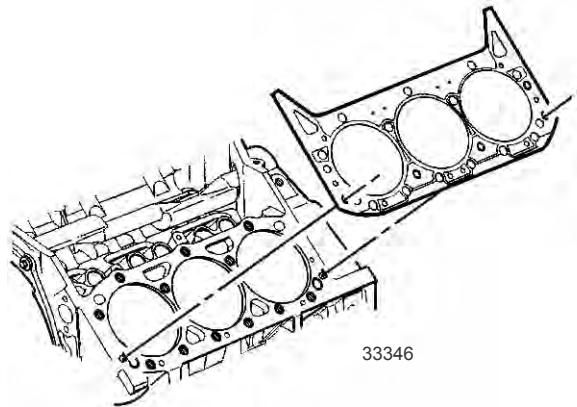
Description		4.3 Liter (262 cid)
Valve spring installed height	Intake	42.92–40.40 mm (1.6090–1.7090 in.) minimum
	Exhaust	



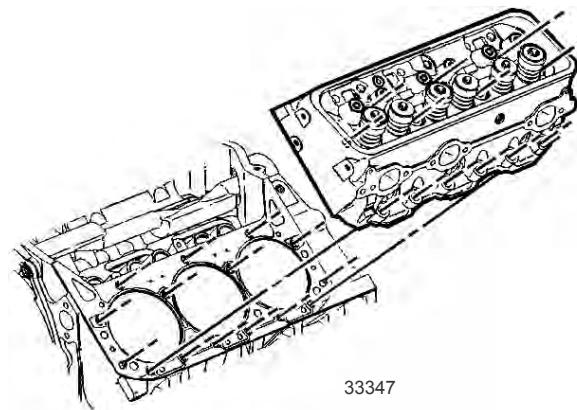
- Typical**
- a - Cut away scale
 - b - Valve spring installed height

Installation

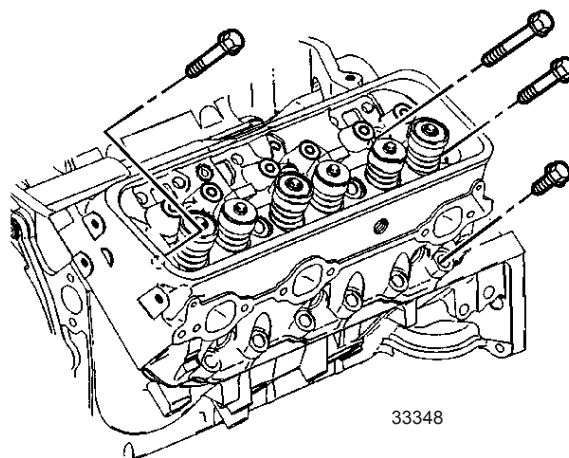
1. Ensure that the engine block and cylinder head sealing surfaces are clean.
2. Place a new head gasket in position over the dowel pins.



3. Carefully set the cylinder head in place over the dowel pins.

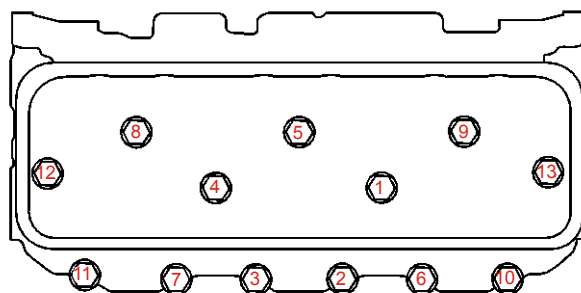


4. Coat the threads of the cylinder head screws with sealant and install the screws finger-tight.



Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Cylinder head screws	Obtain Locally

5. Tighten cylinder head screws to the specified torque in passes using numbered sequence shown.



33349

Cylinder Head Torque Sequence				
Long screws		5, 8, 9, 12, and 13		
Medium screws		1 and 4		
Short screws		2, 3, 6, 7, 10, and 11		

Description		Nm	lb-in.	lb-ft	
Cylinder head screw—Preferred method					
All screws in sequence	First		30	–	22
In sequence angle torque	Final	Long screws	+75°		
		Medium screws	+65°		
		Short screws	+55°		
Cylinder head screw—Optional method					
All screws in sequence	First		35	–	26
	Second		60	–	44
	Final		90	–	66

IMPORTANT: Keep pushrods and rocker arm assemblies together as a matched set. Install parts in the same location.

6. Install the pushrods and rocker arm assemblies in their original positions. Refer to **Rocker Arms and Valve Pushrods**.
7. Install the intake manifold assembly. Refer to **Intake Manifold Assembly**.
8. Install the valve covers.
9. Install any components removed such as the ECM, belt, pulleys, water circulating pump, throttle cable, and other components.
10. Install the exhaust manifolds and elbows.
11. Refill the closed cooling system.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

12. Provide a sufficient water supply to the water inlet holes.
13. Start the engine.

Oil Pan

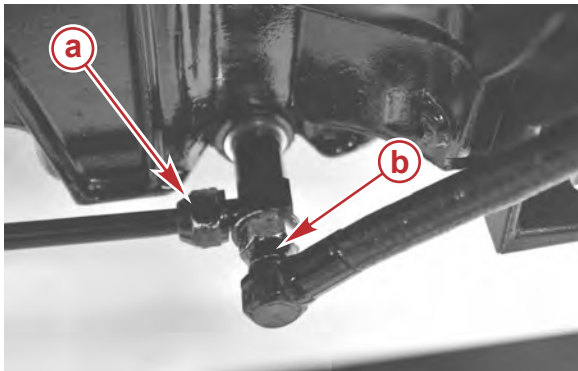
Removal

IMPORTANT: Do not allow dirt or debris to enter the fuel system. Seal the ends of the open fuel lines.

WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. MPI—Remove the fuel cooler and brackets.
2. Drain the engine oil from the oil pan.
3. Remove the dipstick tube flare nut from the T-fitting. Remove the T-fitting from the pan by loosening the jam nut, turning the T-fitting out of the pan.



- a** - Dipstick tube flare nut
b - Oil drain hose fitting jam nut

52805

4. Remove the oil pan.
5. Remove and discard the oil pan gasket.

Cleaning

1. Put on safety glasses.
2. Clean the sealing surfaces of the engine block and oil pan.
3. Clean the oil pan in cleaning solvent.
4. Dry the parts with compressed air.

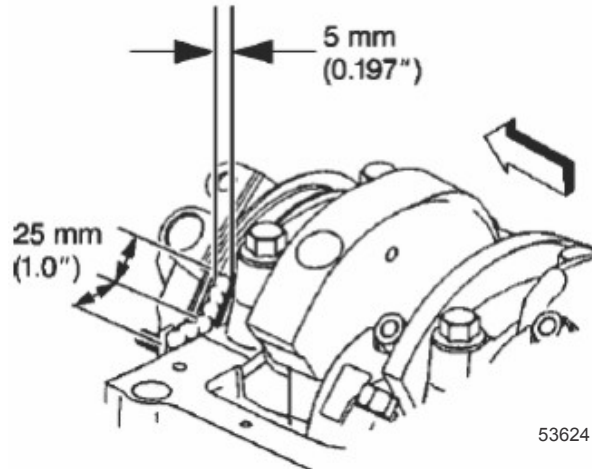
Inspection

1. Inspect the oil pan for cracks, holes, warped sealing surfaces, or other damage.
2. Replace the oil pan if necessary.

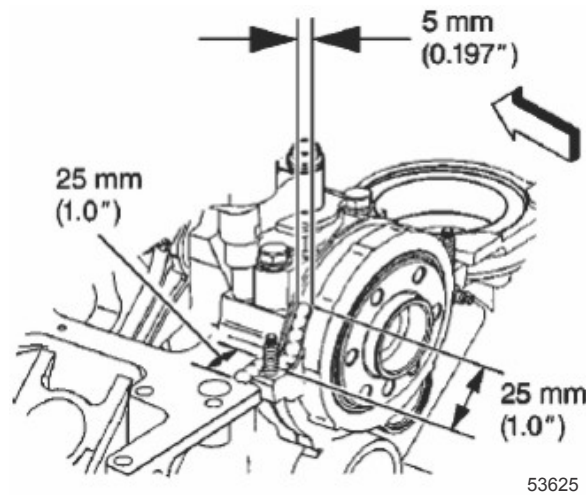
Installation

IMPORTANT: The adhesive sets up in about 15 minutes. Complete the assembly while the adhesive is still wet.

1. Apply a 5 mm (0.197 in.) wide and 25 mm (1.00 in.) long bead of adhesive to both the right and left side joints of the rear seal retainer and joints of the front cover.



Joints of the front cover



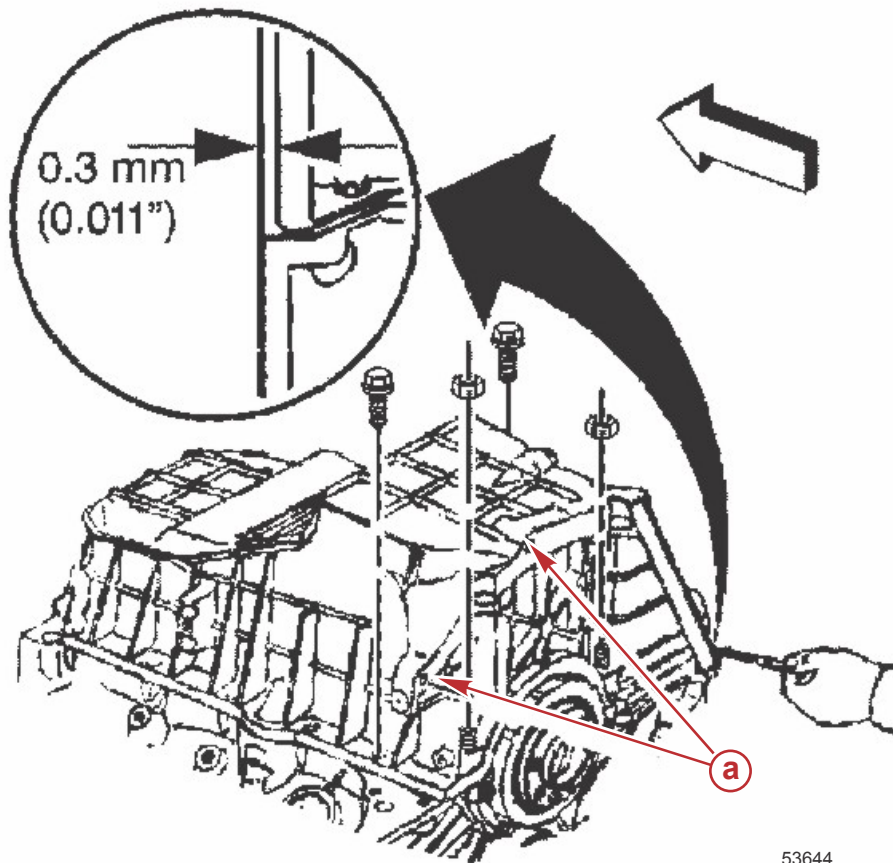
Joints of the rear seal retainer

IMPORTANT: Always install a new oil pan gasket.

NOTE: The oil pan gasket and oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.

2. Install a new oil pan gasket.
3. Install the new oil pan gasket into the groove in the oil pan.
IMPORTANT: The oil pan alignment must always be flush or forward no more than 0.3 mm (0.011 in.) from the rear face of the engine block.
4. Install the oil pan onto the engine block. Press the oil pan gasket into the grooves of the engine front cover and crankshaft rear oil seal housing.
5. Slide the oil pan back against a suitable straight edge.

6. Install the oil pan bolts and nuts, but do not tighten.

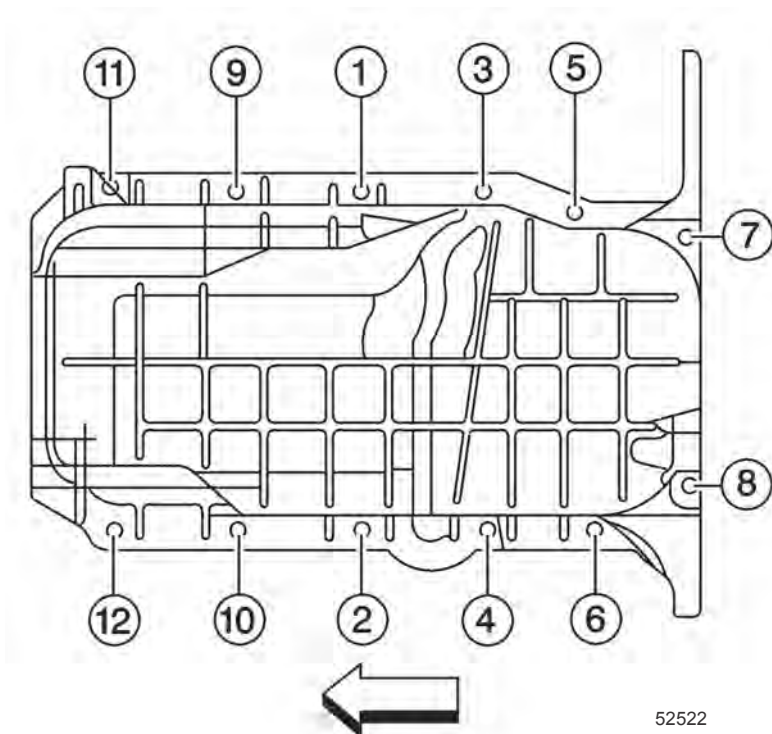


a - Oil pan-to-housing measurement points

7. Measure the pan-to-transmission housing clearance using a feeler gauge and a straight edge. Use a feeler gauge to check the clearance between the oil pan-to-housing measurement points. If the clearance exceeds 0.3 mm (0.011 in.) at any of the three oil pan-to-housing measurement points, then repeat the step until the oil pan-to-housing clearance is within the specification. The oil pan must always be forward of the rear face of the engine block.

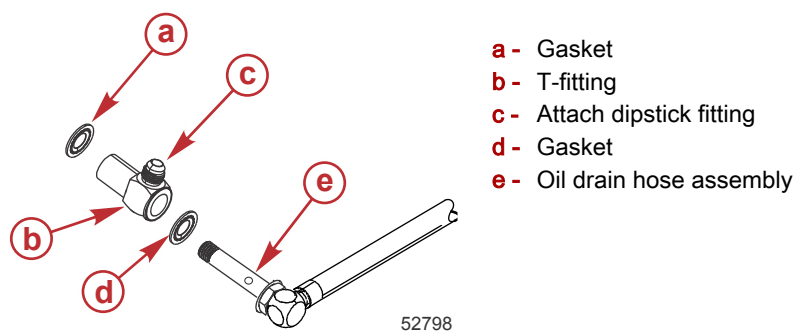
NOTE: If the clearance is more than 0.3 mm (0.011 in.), powertrain durability may be reduced.

8. Tighten the oil pan bolts and nuts in sequence (1–12) to the specified torque. Tighten the oil pan stud nuts and the oil pan bolt or stud to the specified torque.



Description	Nm	lb-in.	lb-ft
Oil pan stud nut	25	–	18
Oil pan bolt or nut	12	106	–

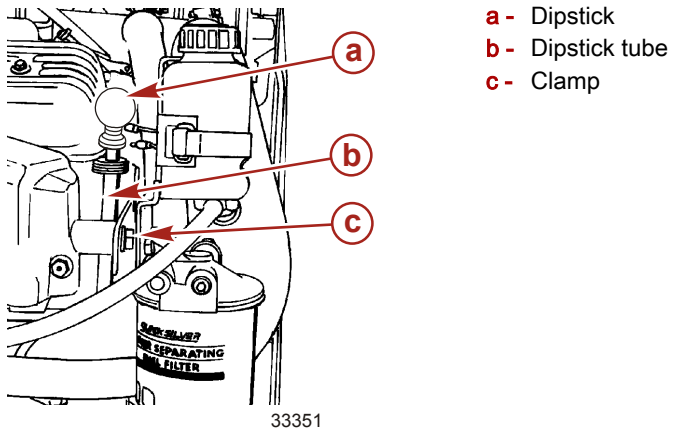
9. Install the gaskets and T-fitting over the oil drain hose assembly, partially thread into the oil pan. Position the tee so the dipstick tube base will attach to the tee.
10. Securely tighten the oil drain tube to the oil pan.



11. Tighten the oil drain nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil drain nut	20	177	–

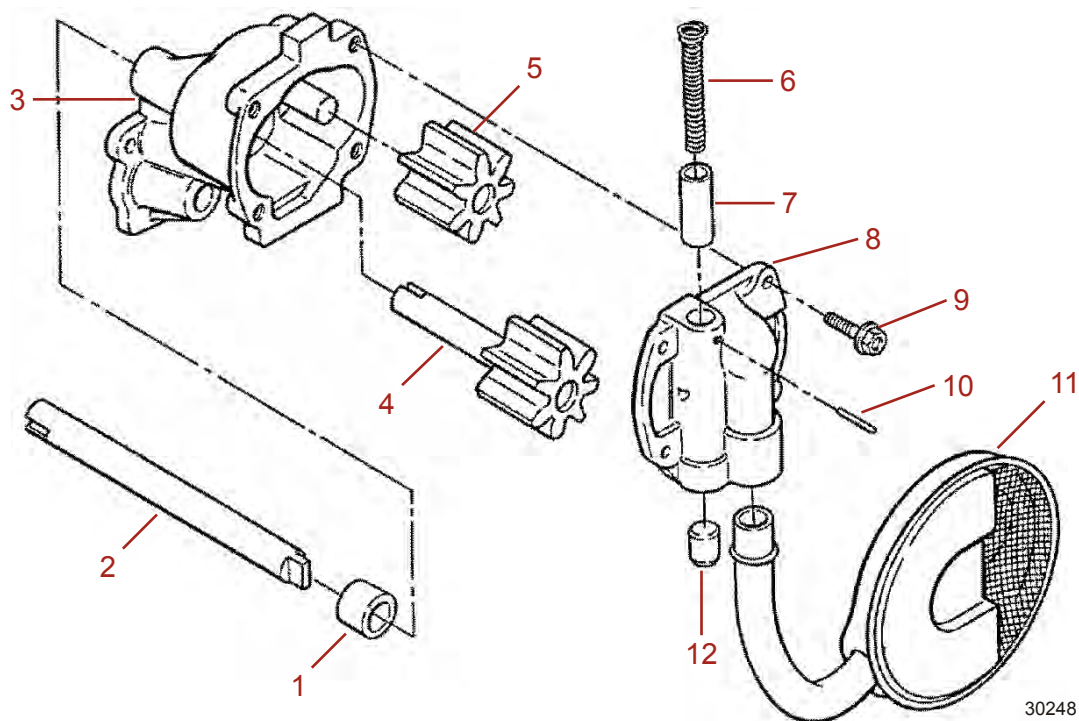
12. Install the appropriate engine oil dipstick.



13. Fill the crankcase with specified engine oil. Refer to **Section 1C**.

Oil Pump

Exploded View



30248

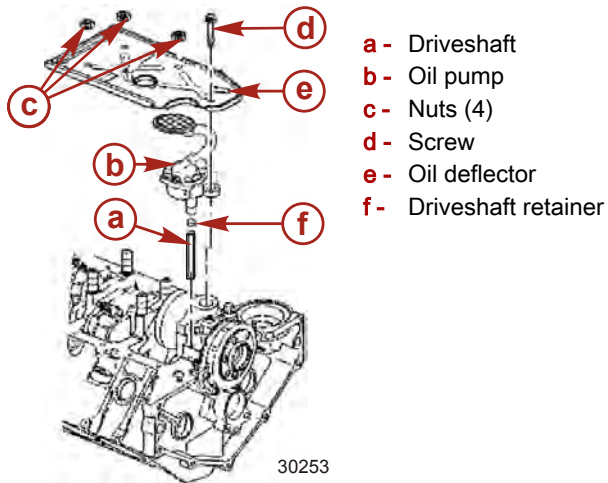
Oil pump assembly

- 1 - Driveshaft retainer
- 2 - Driveshaft
- 3 - Pump body
- 4 - Drive gear and shaft
- 5 - Idler gear
- 6 - Pressure regulator spring
- 7 - Pressure regulator valve
- 8 - Pump cover
- 9 - Screw (4)
- 10 - Retaining pin
- 11 - Pick-up screen and suction pipe
- 12 - Plug

Removal

1. Remove the oil pan.
2. Remove and discard the oil pan gasket.

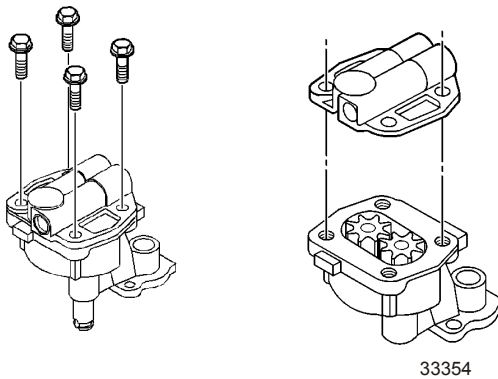
- Remove the oil pan baffle.



- Remove the oil pump, driveshaft retainer, and driveshaft.

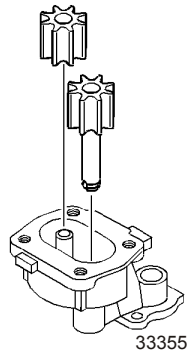
Disassembly

- Remove the pump cover.



IMPORTANT: Gear teeth must be marked for exact repositioning when reassembled.

- Make alignment marks on the idler gear and drive gear teeth.
- Remove the idler gear and drive gear from the pump body.



⚠ CAUTION

Improperly compressed springs or improperly locked valve caps could allow the spring to be ejected with tremendous force, which could cause personal injury. Use care when compressing the valve springs or releasing the valve spring compressor tool.

4. Put on safety glasses.
5. Remove the retaining pin, spring, and pressure regulator valve from the pump cover.

NOTE: Do not remove the suction pipe and pickup screen assembly unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure causing engine damage. The pipe and screen are serviced as an assembly.

6. If the pickup screen and suction pipe assembly require replacement, mount the pump in a soft-jawed vise and extract the suction pipe from the pump.

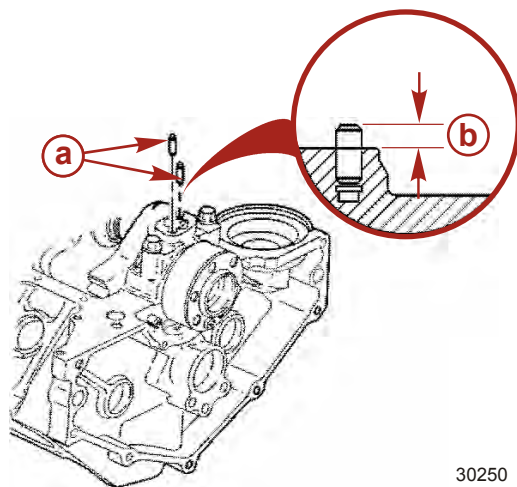
Cleaning

1. Clean all parts in cleaning solvent.
2. Dry the parts with compressed air.

Inspection

IMPORTANT: Pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.

1. Inspect the pump body and cover for cracks or excessive wear.
2. Inspect the pump gears for damage and excessive wear, such as chipped teeth and galling.
3. Check the gear shafts in the pump body for galling, scoring, or excessive shaft-to-bore clearance.
4. Inspect the inside of the pump cover for wear that would permit oil to leak past the gears.
5. Inspect the pickup screen and suction pipe assembly for damage or blockage.
6. Check the pressure regulator valve for smooth, nonbinding fit in its bore in the oil pump cover.
7. Inspect the oil pump locator dowel pins for damage and proper height.



- a -** Dowel pins
b - Oil pump dowel pin height

30250

Description	Height
Oil pump dowel pin	6.4 mm (0.2520 in.)

Reassembly

1. Liberally coat the surfaces of the pressure regulator valve, pressure relief spring, and the pressure regulator bore in the oil pump body with lubricant.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Oil pump components	Obtain Locally

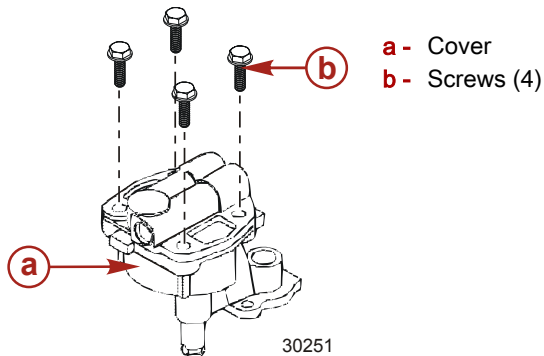
⚠ CAUTION

The pressure regulator valve is spring-loaded, retained by a snap ring. The force of the spring can cause injury during removal. Use caution when disassembling components and wear protective eye equipment.

2. Install the pressure regulator valve and a new pressure relief spring if reusing the existing pump and retaining pin.
3. Liberally coat the surfaces of the oil pump gears and shafts with lubricant.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Surfaces of oil pump gears and shafts	Obtain Locally

4. Install the drive gear in the pump body.
5. Install the idler gear in the pump body with the smooth side of the gear toward the pump cover.
6. Align the gear teeth marks made during disassembly.
7. Fill the gear cavity with engine oil.
8. Install the oil pump cover and cover screws. Tighten the screws in a diagonal pattern to the specified torque.

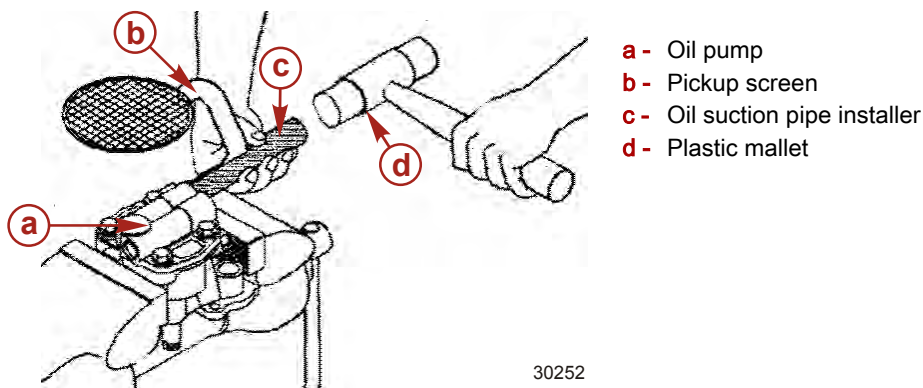


Description	Nm	lb-in.	lb-ft
Oil pump cover screw	12	106	–

9. Turn the oil pump driveshaft by hand to ensure smooth pump operation.
IMPORTANT: Improperly installing the intake pipe can cause improper lubrication, damaging the engine. Install so the pickup screen is parallel to the bottom of the oil pan. Do not twist, shear, or collapse the oil pump intake pipe during installation.
10. If the pickup screen and pipe assembly were removed:
 - a. Mount the pump in a soft-jawed vise.
 - b. Apply sealant to the end of a new suction pipe.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	End of new suction pipe	92-809822

- c. Using the suction pipe installer tool, tap the suction pipe in place with a plastic mallet.

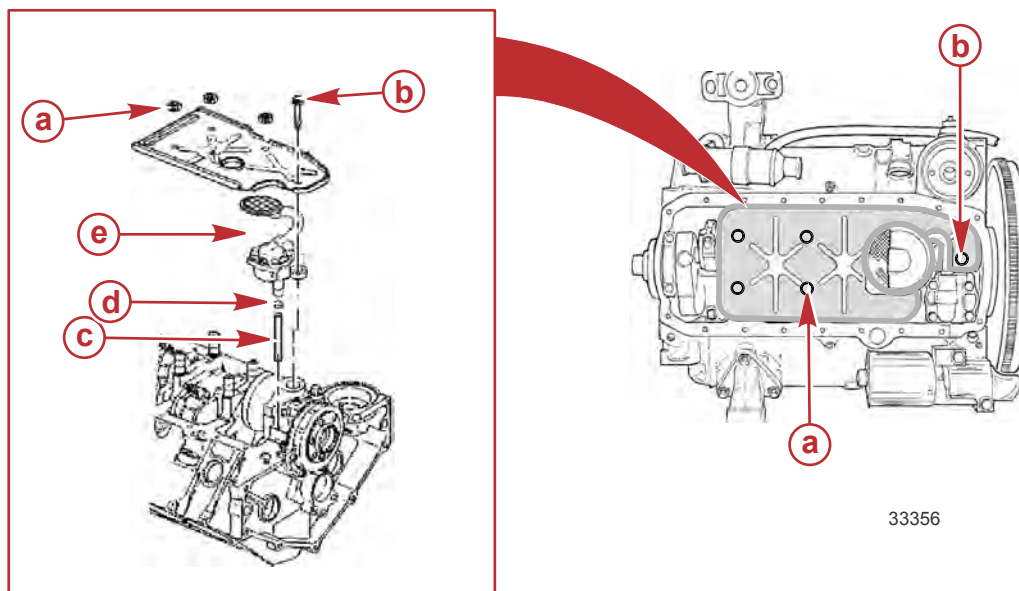


Description	Part Number
Kent-Moore oil suction pipe installer	J21882

- d. Confirm that the pickup screen is parallel to the bottom of the oil pan when installed.

Installation

1. Align the oil pump driveshaft with the distributor driveshaft.
IMPORTANT: Do not reuse the oil pump driveshaft retainer.
2. Install the oil pump driveshaft, a new driveshaft retainer, and the oil pump to the rear main bearing cap.
3. Install the crankshaft oil deflector, nuts, and last oil pump bolt.
4. Tighten the oil pump screw and oil deflector nuts to the specified torque.



- a - Nuts (4)
- b - Screw
- c - Driveshaft
- d - Driveshaft retainer
- e - Oil pump

Description		Nm	lb-in.	lb-ft
Oil pump screw (to rear crankshaft bearing cap)	First	20	177	–
	Final	+ 65°		
Oil deflector nut		40	–	30

IMPORTANT: Always install a new oil pan gasket.

5. Install a new oil pan gasket.
6. Install the oil pan.

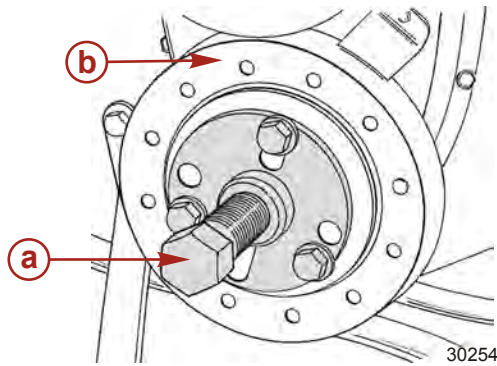
Crankshaft Balancer

Removal

1. Remove the serpentine belt.
2. Remove the crankshaft drive pulley.
3. Remove the crankshaft balancer retaining screw.

NOTE: Do not use a universal claw type puller to remove the crankshaft balancer. The outside ring of the balancer is bonded to the hub with rubber. Use of a claw type puller may damage the balancer.

- Remove the crankshaft balancer with a crankshaft balancer remover and installer tool.



- a - Crankshaft balancer remover and installer tool
b - Crankshaft balancer

Description	Part Number
Kent-Moore crankshaft balancer remover and installer	J23523-F

Cleaning

- Clean the crankshaft balancer in cleaning solvent.
- Dry the parts with compressed air.

Inspection

- Inspect the crankshaft balancer for worn or damaged bolt hole threads.
- Inspect the crankshaft balancer for damaged or deteriorated rubber between the inner and outer hubs.
- Inspect the crankshaft balancer for improperly installed or loose balance weights.
- Inspect the crankshaft balancer keyway for damage.

Installation

IMPORTANT: The inertia weight section of the crankshaft balancer is bonded to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the crankshaft balancer.

- Coat the seal surface of the crankshaft balancer with engine oil.

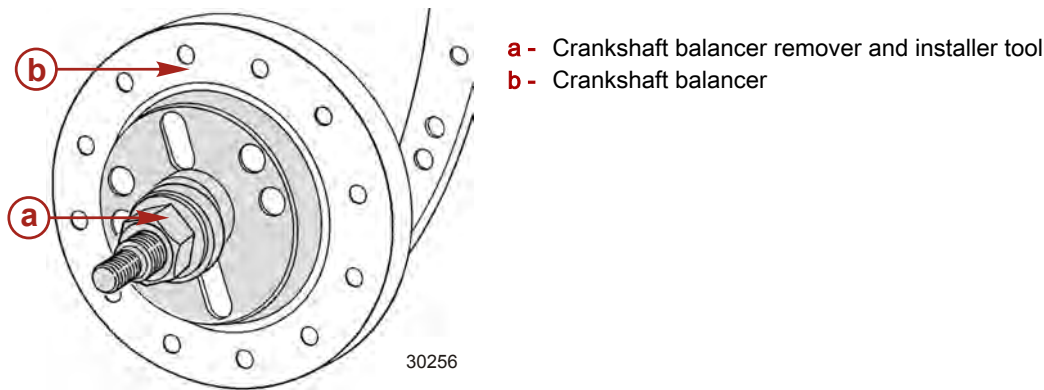
Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Seal surface of the crankshaft balancer	Obtain Locally

- Replace the crankshaft key if it is damaged.
- To prevent oil leaks, apply sealant to the crankshaft balancer keyway.

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Crankshaft balancer keyway	92-809826

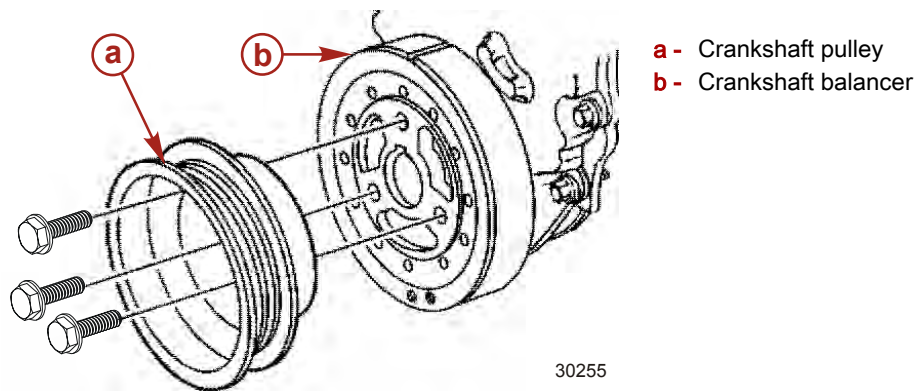
- Align the keyway of the crankshaft balancer with the crankshaft balancer woodruff key.
IMPORTANT: Ensure the balancer is installed all the way onto the crankshaft. This can be checked by seeing if the reluctor can be turned through the sensor opening. A balancer that is not fully seated may cause the engine to misfire.

5. Use the balancer remover and installer tool to press the crankshaft balancer onto the crankshaft.



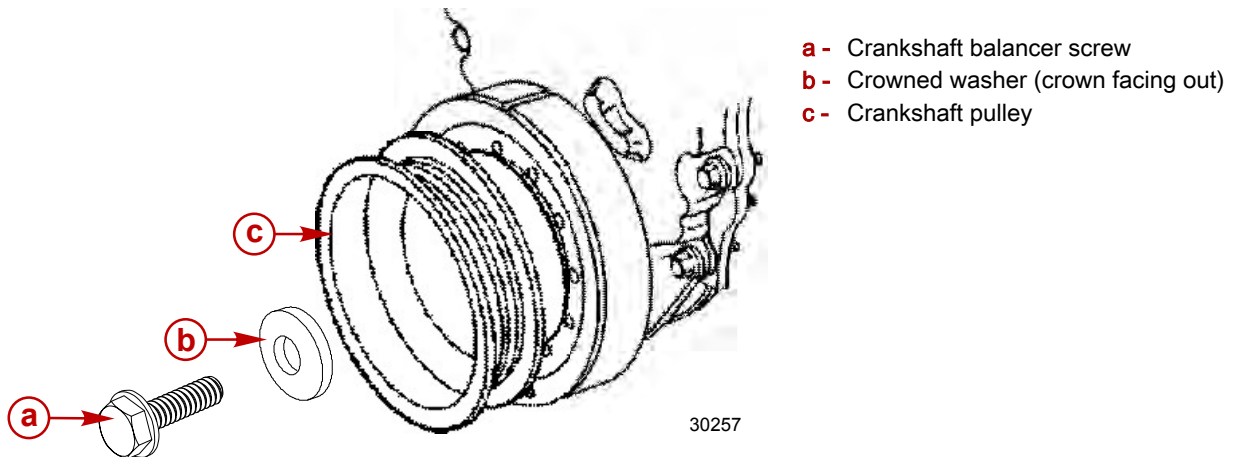
Description	Part Number
Kent-Moore crankshaft balancer remover and installer	J23523-F

- a. Install the plate and screws onto the front of the crankshaft balancer and tighten the screws to the specified torque.
- | Description | Nm | lb-in. | lb-ft |
|--|----|--------|-------|
| Crankshaft balancer remover and installer plate screws | 25 | – | 18 |
- b. Install the screw into the end of the crankshaft.
c. Install the crankshaft balancer remover and installer's bearing, washer, and nut onto the tool screw.
d. Rotate the crankshaft balancer remover and installer's nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reluctor ring.
6. Remove the crankshaft balancer remover and installer.
7. Install the crankshaft pulley and tighten the screws to the specified torque.



Description	Nm	lb-in.	lb-ft
Crankshaft pulley screw	58	–	43

- a. Install the crankshaft balancer washer with the washer crown facing the front of the engine.



- b. Install the crankshaft balancer screw. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Crankshaft balancer screw	95	–	70

8. Install and adjust the serpentine belt.

Crankcase Front Cover Oil Seal (Without Removing Front Cover)

Removal

1. Remove the belt and crankshaft pulley.
2. Remove the crankshaft balancer.
3. Pry the seal out of the front of the cover with a seal removal tool. Be careful not to distort the front cover or damage the crankshaft.

Installation

1. Apply sealant to the seal to crankshaft front cover mating surface.

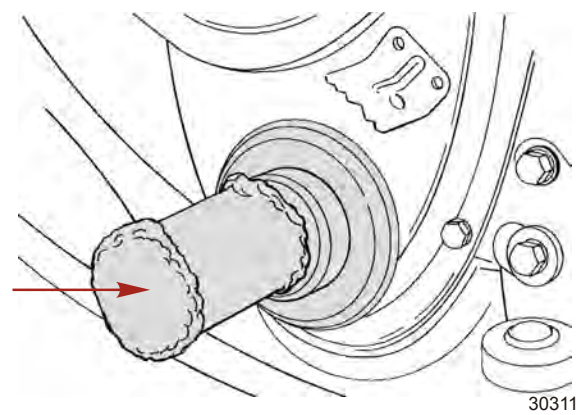
Tube Ref No.	Description	Where Used	Part No.
 128	Loctite 5900 Ultra Black RTV Silicone Sealant	Crankshaft front cover mating surface	92-809826

2. Lubricate the rubber sealing surface.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Rubber sealing surface	Obtain Locally

3. Install the new seal with the open end of the seal facing inward. Using Crankcase Front Cover Aligner and Seal Installer, drive the seal in until it seats.

IMPORTANT: Do not use excessive force to drive in seal.



Crankcase Front Cover Aligner and Seal Installer

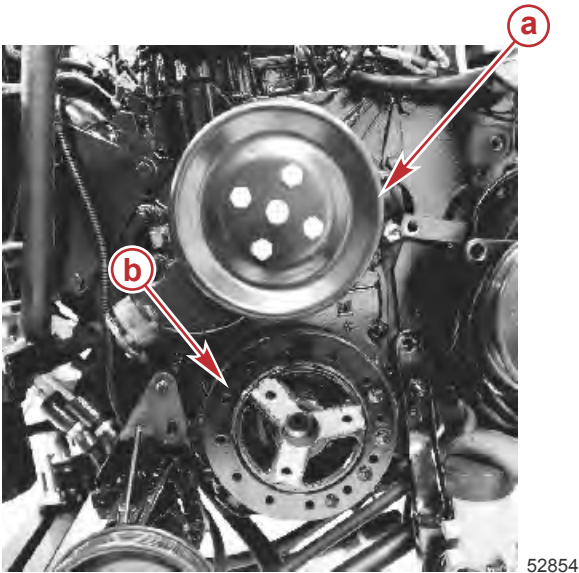
Description	Part Number
Crankcase Front Cover Aligner and Seal Installer	J35468

- 4. Install the crankshaft balancer.
- 5. Install the crankshaft pulley and belt.

Crankcase Front Engine Cover

Removal

- 1. Drain the seawater and closed cooling systems.
- 2. Remove the serpentine belt.
- 3. Remove the serpentine belt tensioner and bracket.
- 4. Remove the idler pulley with bracket.
- 5. Remove the crankshaft pulley.



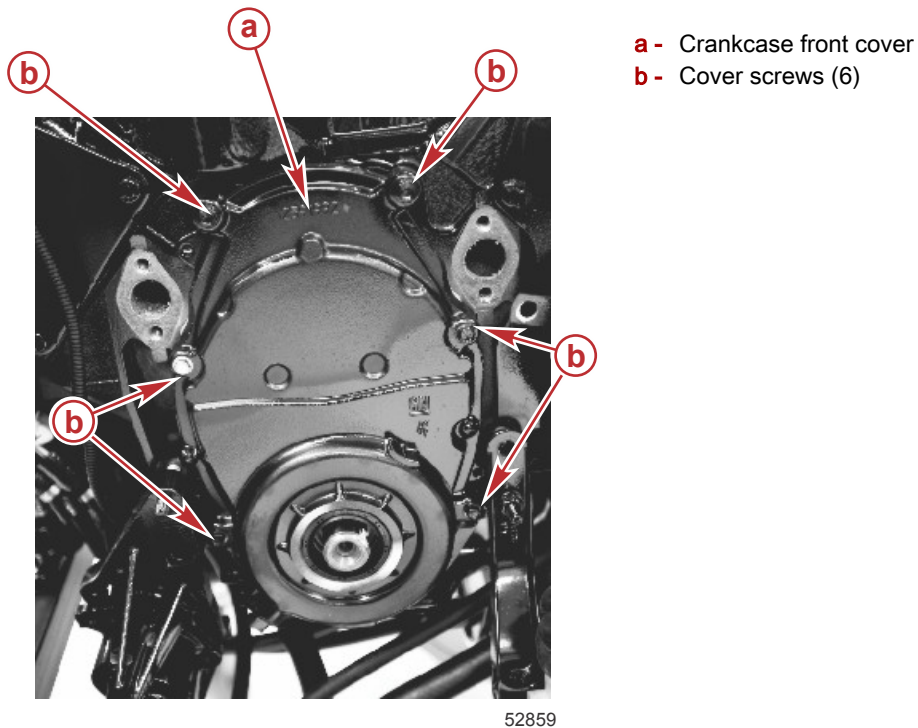
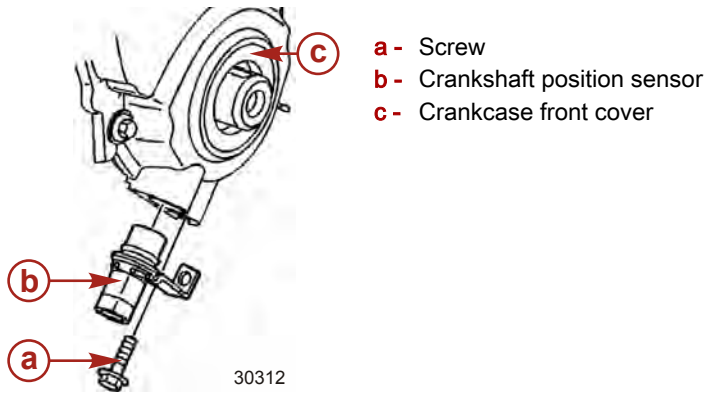
- a - Water circulating pump
- b - Crankshaft balancer

- 6. Remove the hoses from the water circulating pump.
- NOTE:** Do not use a universal claw type puller to remove the crankshaft balancer. The outside ring of the balancer is bonded to the hub with rubber. Use of a claw type puller may damage the balancer.
- 7. Remove the crankshaft balancer with a crankshaft balancer remover and installer tool.

Description	Part Number
Kent-Moore crankshaft balancer remover and installer	J23523-F

- 8. Remove the water circulating pump.

9. Remove the oil pan. Refer to **Oil Pan Removal**.
10. Remove the crankshaft position sensor.



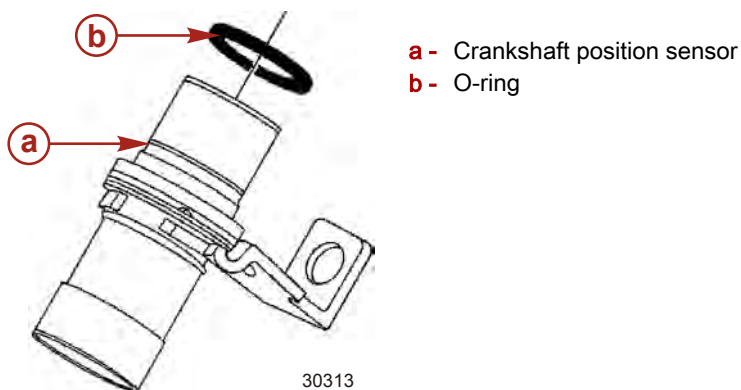
11. Remove and discard the crankcase front cover.

IMPORTANT: The crankcase front cover is not reusable per manufacturer's specification. It must be replaced if removed.

Cleaning and Inspection

IMPORTANT: Clean all components thoroughly.

1. Clean old gasket material and sealant from the sealing surfaces on the engine block.
2. Remove and discard the crankshaft position sensor O-ring seal.



Installation

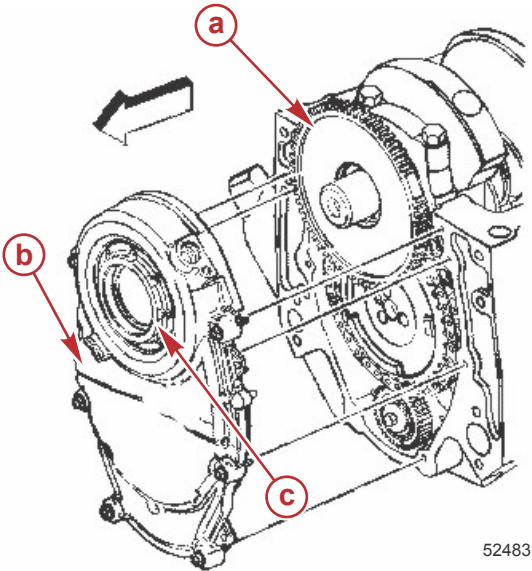
NOTE: New front covers are complete with gasket and crankshaft seal.

- 1. Lubricate the new crankshaft seal with clean engine oil.

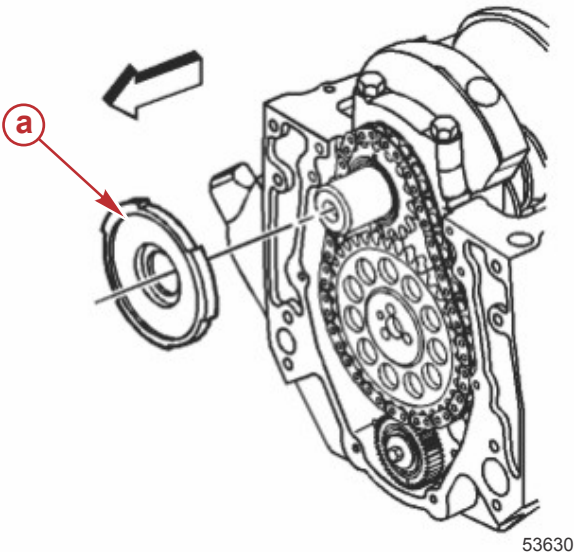
Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Front cover crankshaft seal	Obtain Locally

- 2. Install the new crankcase front cover, ensuring that the holes in the cover align with the dowel pins in the block. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Front cover screw	12	106	–



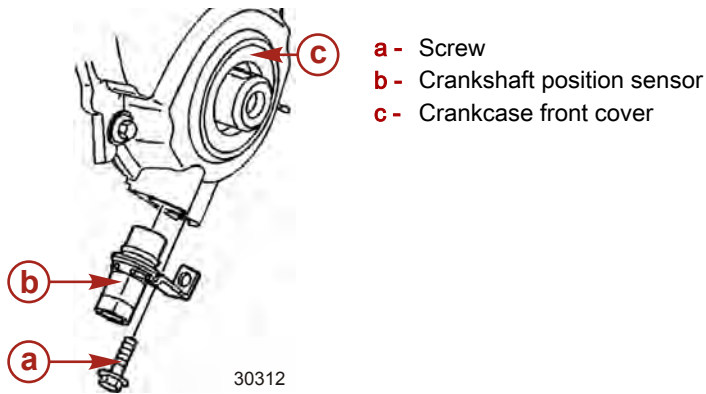
- 58X reluctor ring**
- a - 58X reluctor ring
 - b - Crankcase front cover
 - c - Front crankshaft seal



- 3X reluctor ring**
- a - 3X reluctor ring

- 3. Install a new crankshaft position sensor O-ring seal.
IMPORTANT: The crankshaft position sensor must be fully seated in the front cover. Erratic engine operation can occur if sensor is not properly installed.

4. Install the crankshaft position sensor. Ensure that the sensor is fully seated in the cover.



5. Install the crankshaft position sensor screw. Tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Crankshaft position sensor screw	9	80	–

6. Install the oil pan. Refer to **Oil Pan Installation**.

7. Install the crankshaft balancer. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Crankshaft balancer screw	95	–	70

8. Install the water circulating pump. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Water circulating pump screws	45	–	33

9. Install the hoses to the water circulating pump.

10. Fill the crankcase with engine oil.

11. Fill the closed cooling system, if equipped.

12. Install the crankshaft pulley. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Crankshaft pulley screws	58	–	43

13. Install the serpentine belt tensioner and bracket.

14. Install the serpentine belt idler pulley and bracket.

15. Install the serpentine belt.

NOTICE

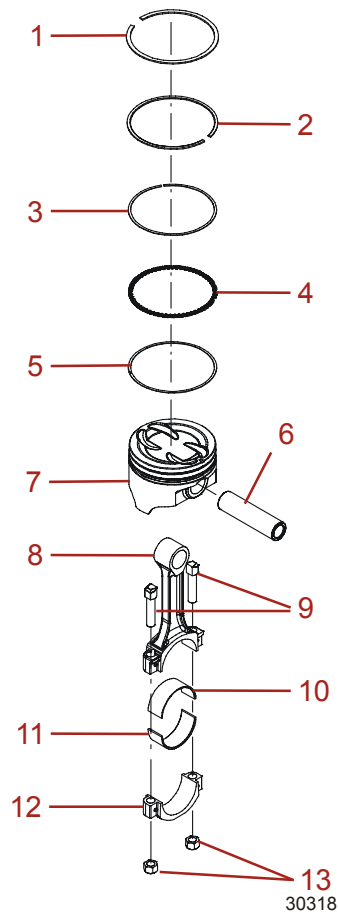
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

16. Provide a sufficient supply of water to the engine seawater system.

17. Start the engine and check for water and oil leaks.

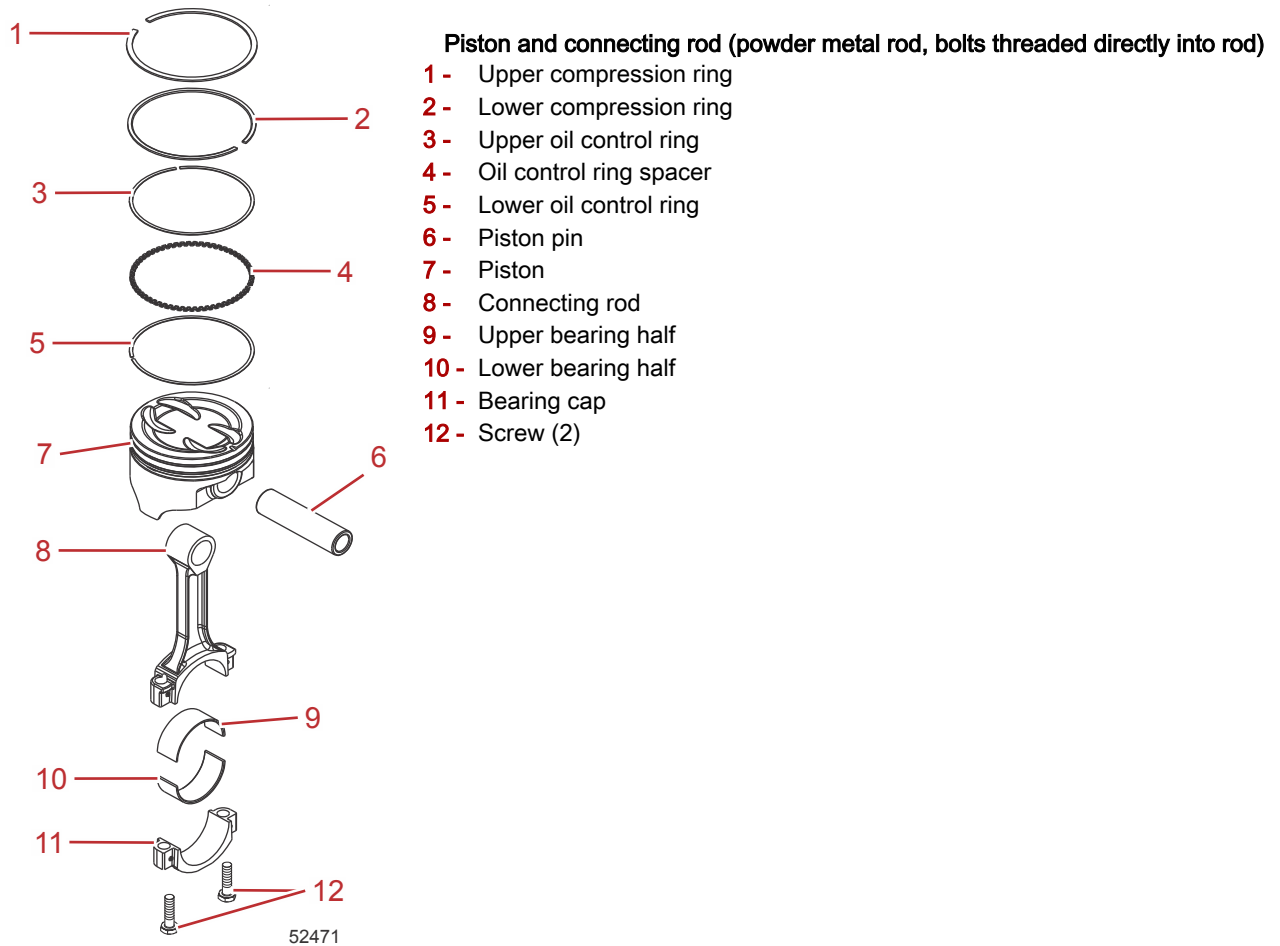
Connecting Rod, Bearings, and Piston Assembly

Exploded View



Piston and connecting rod (forged steel rods with through bolt and nut)

- 1 - Upper compression ring
- 2 - Lower compression ring
- 3 - Upper oil control ring
- 4 - Oil control ring spacer
- 5 - Lower oil control ring
- 6 - Piston pin
- 7 - Piston
- 8 - Connecting rod
- 9 - Rod bolt (2)
- 10 - Upper bearing half
- 11 - Lower bearing half
- 12 - Bearing cap
- 13 - Nuts (2)



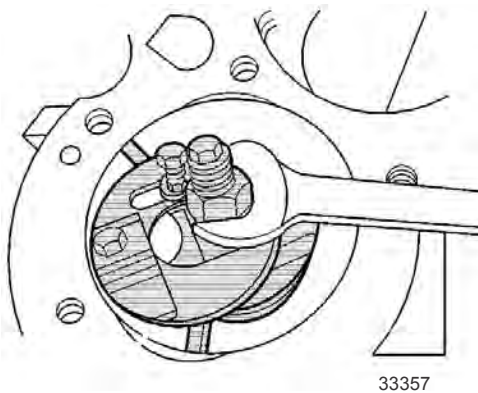
Removal

1. Remove the front engine cover. Refer to **Crankcase Front Engine Cover**.
2. Remove all components on the front of the engine.
3. Remove exhaust elbow and manifold assemblies. Refer to **Section 7 - Exhaust Systems**.
4. Remove the valve covers. Refer to **Valve Cover**.
5. Remove distributor and intake manifold assembly. Refer to **Intake Manifold Assembly**.
6. Remove cylinder heads. Refer to **Cylinder Head**.
7. Remove dipstick tube and oil pan. Refer to **Oil Pan**.
8. Remove crankshaft oil deflector and oil pump. Refer to **Oil Pump**.
9. Using a ridge reamer, remove any ridge or combustion deposits from the top of the cylinder bore.

Description	Part Number
Cylinder bore ridge reamer	NLA

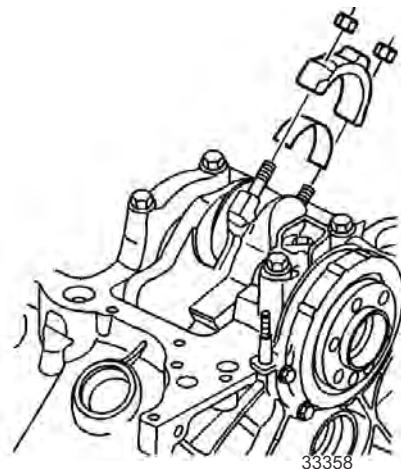
- a. Turn the crankshaft until the piston is at the bottom of the stroke.
- b. Place a cloth on top of the piston to collect cuttings.
- c. Use the cylinder bore ridge reamer to remove ridge or deposits.
- d. Turn the crankshaft until the piston is at top of the stroke.

- e. Remove the cloth and cuttings.

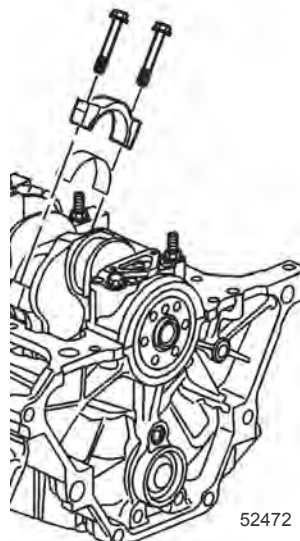


Cylinder bore ridge reamer

10. Turn the crankshaft to gain access to the connecting rods and screws.
IMPORTANT: Mark the location of each connecting rod assembly so that they can be reassembled in the same location later.
11. Mark connecting rods and bearing caps to corresponding cylinder number (port bank 1, 3, and 5; starboard bank 2, 4, and 6 from front to rear on the same side as the piston thrust).
IMPORTANT: Before removing the connecting rod cap, mark and organize the connecting rods and caps so that they can be installed in the same location later.
12. Remove the connecting rod bearing cap.



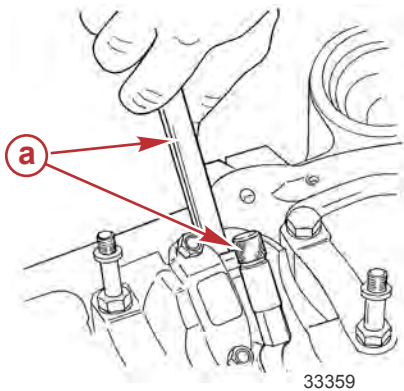
Forged steel rod



Powder metal rod

IMPORTANT: Wrap a clean, lint free towel around the connecting rod ends when removing the piston from the cylinder so as not to damage the crankshaft journals or cylinder bore.

13. Cover the connecting rod screw threads with screw guides. It is acceptable to use clean rubber tubing for the connecting rod screw guides.



a - Connecting rod screw guides (J5239)

Description	Part Number
Connecting rod screw guides	J5239

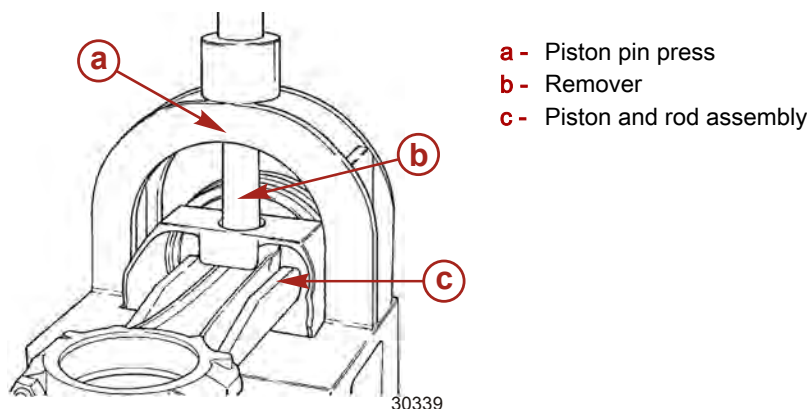
14. Push the piston and connecting rod out of the cylinder.
IMPORTANT: The mating surfaces of the connecting rods and the connecting rod bearing caps form an individual fit and as a result must not be interchanged or damaged under any circumstances. To avoid damage, do not lay connecting rods or connecting rod bearing caps on their mating surfaces.
15. Remove the connecting rod bearings. Keep the bearings with the original connecting rod and connecting rod cap together as a matched set.

Disassembly

1. Remove the piston rings from the pistons.

Piston Ring Expander	91-24697
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2. Press the piston pin from the connecting rod using a piston pin press. Follow the tool manufacturer's instructions.



Description	Part Number
Piston pin press	J24086-C

3. Mark, separate, and organize the parts so that they can be installed in the same locations.

Cleaning

1. Connecting rods
 - a. Clean the connecting rods in cleaning solvent.
 - b. Dry parts with compressed air.
2. Connecting rod bearings
 - a. Clean the connecting rod bearings in cleaning solvent. Do not scratch the bearing contact surfaces.
 - b. Wipe the bearings clean with a soft cloth.
 - c. Dry parts with compressed air.
3. Pistons
 - a. Clean the pistons in cleaning solvent.
 - b. Clean varnish from the piston skirt and pin with a suitable cleaning solvent.
 - c. Clean the piston ring grooves.
 - d. Clean the piston oil lubrication holes and slots.
 - e. Dry parts with compressed air.
4. Piston pin
 - a. Clean the parts in cleaning solvent.
 - b. Dry the parts with compressed air.

Preliminary Inspection

IMPORTANT: All measurements should be taken when components are at room temperature.

1. Connecting rod
 - a. Check for twisted or bent connecting rods.
 - b. Inspect for nicks and cracks.
 - c. Inspect for damage to the bearing cap or bolt threads.
 - d. Replace damaged connecting rods.
2. Connecting rod bearings

NOTE: Refer to **Main Bearing Inspection** for examples of common bearing failures.

 - a. Inspect the connecting rod bearings for craters, pockets, or flattened sections.
 - b. Inspect the connecting rod bearings for excessive scoring, discoloration, or damage.
 - c. Inspect the connecting rod bearings for dirt or debris imbedded in the bearing material.
 - d. Replace damaged or faulty bearings.

Connecting Rod Bearing Clearance, Micrometer Method

IMPORTANT: The micrometer method is the preferred method of determining connecting rod bearing clearance.

IMPORTANT: All measurements should be taken when components are at room temperature.

Connecting rod bearings are of the precision insert type and do not use shims for adjustment. Replace the bearing if clearance is found to be excessive. Service bearings are available in standard size and 0.001 in. and 0.002 in. undersized for use with new and used standard size crankshafts. They are also available in 0.010 in. and 0.020 in. undersized for use with reconditioned crankshafts.

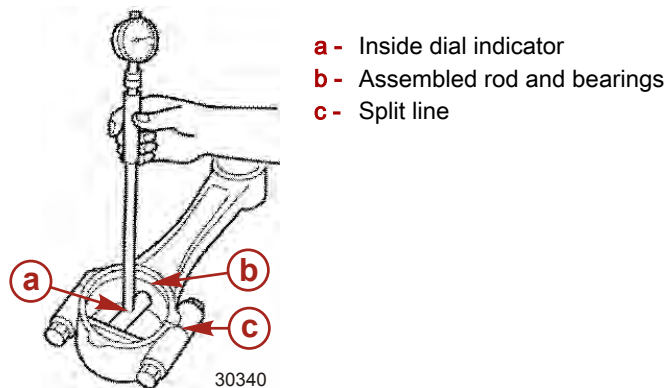
NOTE: When removing a connecting rod cap, you may find a 0.010 in. undersized bearing. These are used during manufacturing for selective fitting.

1. Wipe both upper and lower connecting rod bearings clean with a soft cloth.
2. Install the upper and lower connecting rod bearings.
3. Install the bearing cap.
4. In a two step sequence, tighten the bearing cap nuts to the specified torque.

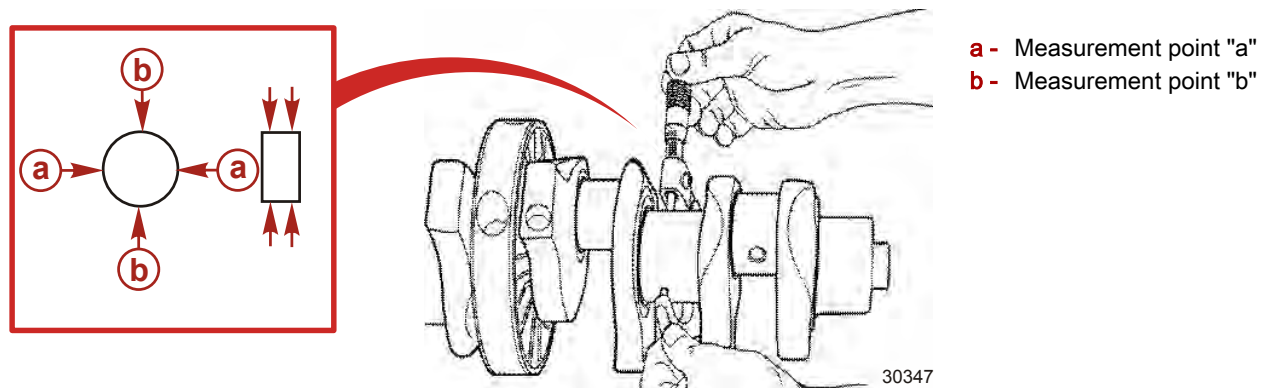
Description		Nm	lb-in.	lb-ft
Connecting rod nut (forged steel rod)	First	27	–	20
	Final	+ 70°		
Connecting rod bolt (powder metal rod)	First	20	177	–
	Final	+ 100°		

5. Use an inside dial indicator to measure the connecting rod bearing inside diameter and out of round and taper. Measure in several places approximately 90° apart and average the measurements.

IMPORTANT: Do not measure inside diameter close to the connecting rod and bearing split line.



6. Record the measurements.
7. Wipe the crankshaft connecting rod journal with a clean cloth. Remove any oil film.
8. Measure the crankshaft connecting rod journal diameter with a micrometer. Take a second measurement at a position on the connecting rod journal at a point 90° from the first measurement.



Description		4.3 Liter (262 cid)
Diameter		57.116–57.148 mm (2.2487–2.2497 in.)
Taper	Production	0.00508 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.007 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

NOTICE

Inadequate clearance or interference between the bearing and its mating surface will result in rapid bearing wear and catastrophic component failure. Check all bearing clearances.

9. If the crankshaft rod bearing journal diameters are not within specifications, replace or recondition the crankshaft.
10. If the crankshaft rod bearing journal diameters are within specifications, determine bearing clearance by subtracting the crankshaft connecting rod journal outer diameter from the inner diameter of the bearing from step 5.

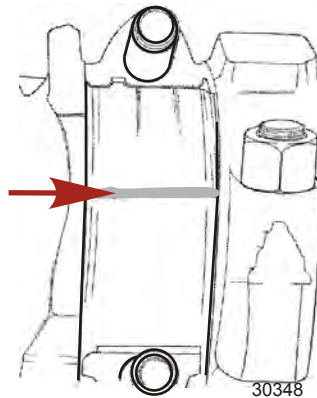
Description		4.3 Liter (262 cid)
Clearance	Production	0.038–0.078 mm (0.0015–0.0031 in.)
	Service limit	0.025–0.063 mm (0.0010–0.0025 in.)

11. If the clearance exceeds specifications, select a new, correct size bearing, and recheck the bearing clearance.

Connecting Rod Bearing Clearance, Plastic Gauge Method

The plastic gauge method is an optional method of determining connecting rod bearing clearance. Micrometer measurement is the preferred method.

1. Wipe both upper and lower bearings and the crankshaft connecting rod journal with a clean soft cloth. Remove any oil film.
2. Install the bearings in the connecting rod and cap.
IMPORTANT: To obtain accurate measurements the connecting rod and upper bearing must be seated against the connecting rod journal before installing the lower bearing and rod cap.
3. Rotate the crankshaft or move the connecting rod until the upper bearing is fully seated against the connecting rod journal being measured.
IMPORTANT: Position the plastic gauge on the crankshaft journal so that it will be centered as it lays across the bearing shell.
4. Place a piece of gauging plastic parallel to the crankshaft on the middle of the open crankshaft connecting rod journal surface as shown.



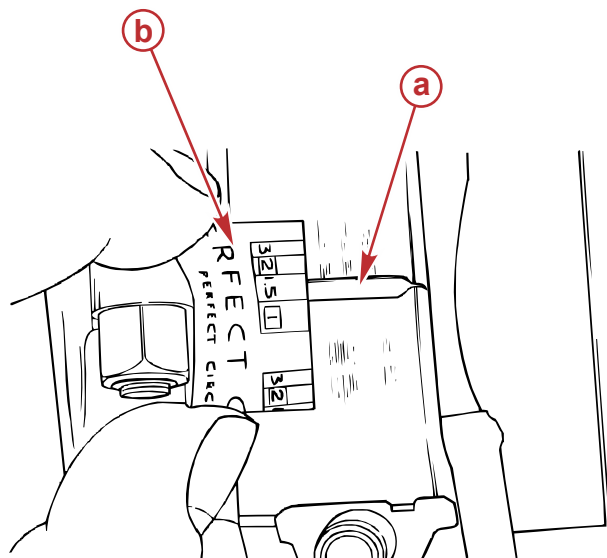
Plastic gauge placement

5. Install the bearing cap.
6. Tighten the bearing cap nuts in two steps to the specified torque.

Description		Nm	lb-in.	lb-ft
Connecting rod nut (forged steel rod)	First	27	–	20
	Final	+ 70°		
Connecting rod bolt (powder metal rod)	First	20	177	–
	Final	+ 100°		

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

- Without rotating the crankshaft, remove the bearing cap and use the scale on the gauging plastic envelope to measure the gauging plastic width at the widest point.



- a - Compressed gauging
b - Scale

53525

Description		4.3 Liter (262 cid)
Journal clearance	Production	0.038–0.078 mm (0.0015–0.0031 in.)
	Service	0.025–0.063 mm (0.0010–0.0025 in.)

If the clearance is not within specifications, select a new, correct size bearing and recheck the clearance. A standard and undersized connecting rod bearing combination may result in the proper clearance.

NOTE: If clearance cannot be brought to within specifications, the crankshaft connecting rod journal will have to be ground undersized. If the connecting rod journal is already at maximum undersized, replace the crankshaft.

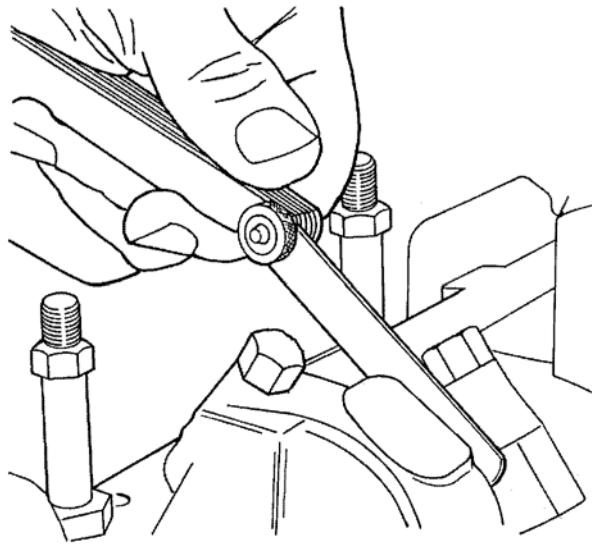
- Coat the selected bearing surface with oil.
- Install the connecting rod cap.
- Tighten the bearing cap nuts in two steps to the specified torque.

Description		Nm	lb-in.	lb. ft.
Connecting rod nut 4.3 Liter (262 cid)	First	27	–	20
	Final	+ 70°		

Connecting Rod Side Clearance

- When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankshaft) to establish clearance.

2. Measure the side clearance between each pair of connecting rod caps.



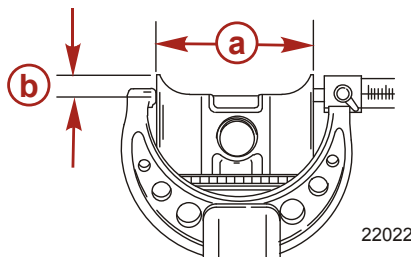
Measuring connecting rod side clearance

Description	4.3 Liter (262 cid)
Rod side clearance	0.15–0.44 mm (0.0059–0.017 in.)

Piston Inspection

NOTE: Cylinder bore and taper must be within specifications before pistons can be considered for reuse.

1. Inspect the piston for cracked ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts, and eroded areas at the top of piston.
2. Inspect the ring grooves for nicks and burrs that may cause the rings to bind.
3. Inspect the piston for wear by checking the piston to bore clearance:
 - a. Measure the piston diameter 11.0 mm (0.433 in.) from the bottom of the skirt at a right angle to the piston pin bore as shown.



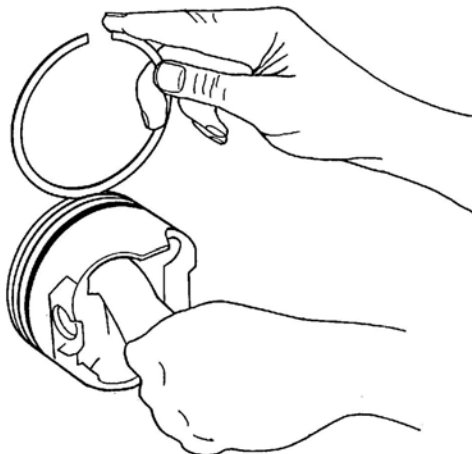
Measuring piston diameter
a - Piston diameter
b - Measurement location

- b. Measure the cylinder bore diameter with a telescope gauge. Refer to **Engine Block Inspection**.
- c. Subtract the piston diameter from the cylinder bore diameter to determine piston to bore clearance.
- d. Replace the piston if the piston to bore clearance is less than specified. Refer to **Crankshaft, Main Bearings, and Engine Block** for cylinder reconditioning and piston replacement.

Piston to Bore Clearance	
Description	4.3 Liter (262 cid)
Production	0.018–0.061 mm (0.0007–0.0024 in.)
Service	0.075 mm (0.0029 in.) maximum

4. Insert the appropriate type of piston ring into each of the piston ring grooves.
5. Roll the ring around the groove to ensure that the ring moves freely around the entire piston.
 - If the ring binds, check the piston ring groove for deposits. Clean out all deposits.
 - If the ring binds, check the piston ring groove for nicks or burrs. Minor internal damage can be dressed with a fine file.

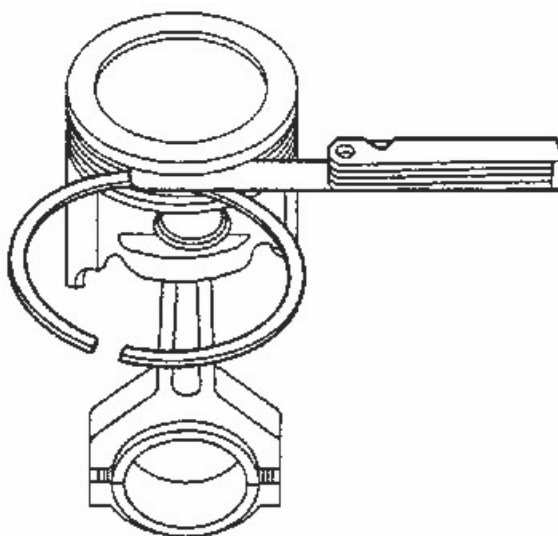
- If the piston ring groove is clean and free of defects check groove with a different ring. The ring used for inspection may be bent.



19616

Checking piston ring grooves

- Using a feeler gauge, measure the clearance between the piston ring and the piston ring groove at several points around the piston.



Measuring piston ring to piston clearance

Top Compression		
Description		4.3 Liter (262 cid)
Groove clearance	Production	0.030–0.070 mm (0.0012–0.0028 in.)
	Service	0.030–0.085 mm (0.0012–0.0033 in.)
Second Compression		
Description		4.3 Liter (262 cid)
Groove clearance	Production	0.040–0.080 mm (0.0015–0.0031 in.)
	Service	0.030–0.085 mm (0.0012–0.0033 in.)

Oil Control		
Description		4.3 Liter (262 cid)
Groove clearance	Production	0.046–0.196 mm (0.0018–0.0077 in.)
	Service	0.046–0.200 mm (0.0018–0.0079 in.)

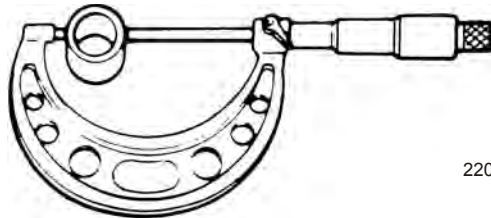
- Replace the piston if groove clearance exceeds the specified limit.

Piston Pin Inspection

IMPORTANT: Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.

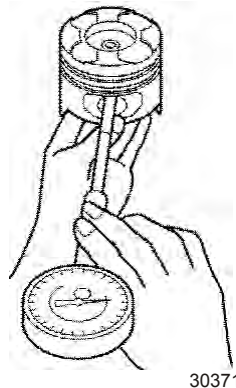
NOTE: Piston pin bores and piston pins must be free of scuffing and deposits before they can be accurately measured.

- Inspect the piston pin bores and piston pins for wear.
- Measure the piston pin diameter with a micrometer.



Measuring piston pin diameter

- Measure the piston pin bore inside diameter with a dial bore gauge or inside micrometer.



Measuring piston pin bore diameter

- Subtract the piston pin diameter from the piston pin bore diameter to determine clearance.

Description		4.3 Liter (262 cid)
Diameter		23.545–23.548 mm (0.9270–0.9271 in.)
Clearance	Production	0.013–0.023 mm (0.0005–0.0009 in.)
	Service limit	0.025 mm (0.0010 in.) maximum
Fit in connecting rod		0.013–0.048 mm (0.0005–0.0019 in.) interference

- Measure the connecting rod piston pin bore diameter with a dial bore gauge or inside micrometer.
- Subtract the piston pin diameter from the connecting rod piston pin bore diameter to determine fit in rod clearance.
- If clearance exceeds service limit, replace the piston and piston pin assembly.

Piston Ring Gap Inspection

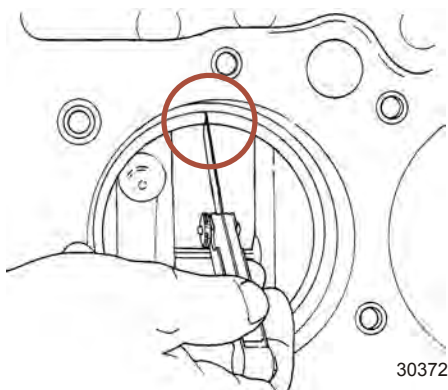
IMPORTANT: Fit each compression ring to the cylinder in which it is going to be used.

- Insert a piston ring into the cylinder bore.
- Use an inverted piston to push the piston ring 6.0 mm (1/4 in.) into the cylinder bore.

NOTE: Ensure that the piston and ring are square with the cylinder wall.

- Remove the piston.

- Using a feeler gauge, measure the piston ring gap.



Measuring piston ring gap

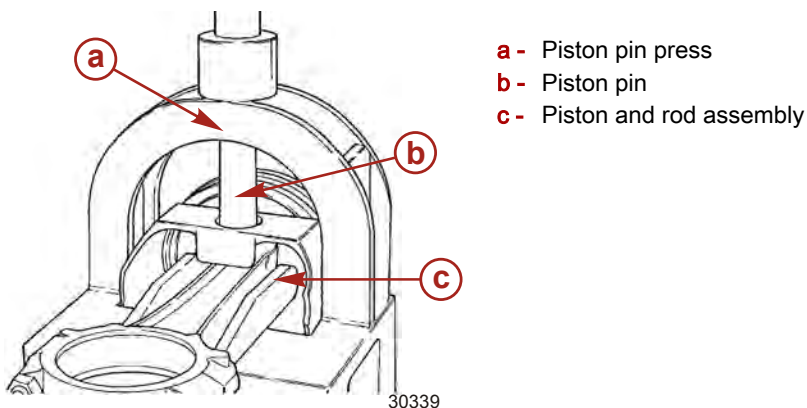
Description		4.3 Liter (262 cid)
Top compression ring gap	Production	0.25–0.40 mm (0.010–0.016 in.)
	Service	0.25–0.40 mm (0.010–0.016 in.)
Second compression ring gap	Production	0.46–0.66 mm (0.018–0.026 in.)
	Service	0.46–0.90 mm (0.018–0.035 in.)
Oil control ring gap	Production	0.25–0.76 mm (0.010–0.0299 in.)
	Service	0.25–0.89 mm (0.010–0.035 in.)

- Replace ring if the gap exceeds service limits. If the ring gap is below specifications, remove the ring and try another.

Assembly

Piston

- Assemble the piston and connecting rod using the piston pin press. Follow the tool manufacturer's instructions.



Description	Part Number
Kent-Moore piston pin press	J24086-C

- Check that the piston will pivot and slide freely on the piston pin. Piston and rod assemblies that bind have a piston pin or bore out of specification and require replacement of the piston and pin assembly
- If a new connecting rod has been installed, mark the connecting rod and cap (on the with slots for the connecting rod bearing tangs) with cylinder number in which it will be installed.

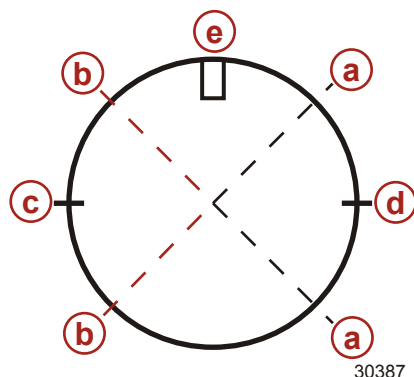
Piston Ring Installation

IMPORTANT: All compression rings are marked on the upper side of the ring. When installing compression rings, ensure that the marked side is toward the top of the piston.

NOTE: Oil control rings are a three-piece type, consisting of two rings and a spacer.

- Select rings appropriate for the cylinder bore and piston size.

2. Install the oil control ring spacer in its groove.
3. Hold the spacer ends together and install the lower oil control ring with its gap properly located.



Ring gap locations

- a** - Oil ring spacer gap
- b** - Oil ring gaps
- c** - Lower compression ring gap
- d** - Upper compression ring gap
- e** - Front of engine

4. Install the upper oil control ring with its gap properly located.
5. Flex the oil ring assembly to ensure that the rings move freely.
IMPORTANT: Use the piston ring expander for compression ring installation.

Piston Ring Expander	91-24697
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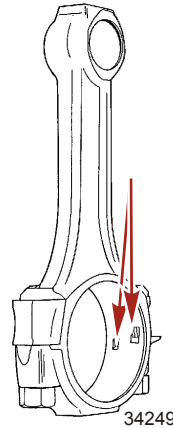
6. Using a piston ring expander, install the lower and upper compression rings with the marked side up.

Installation

IMPORTANT: Cylinder bores must be thoroughly clean before piston installation.

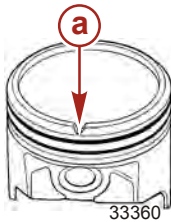
IMPORTANT: When reassembling the pistons and connecting rods, the following must be kept in mind:

- The piston and pin are machine fitted to each other and must remain together as a matched set. Do not mix pistons and pins.
- If the original pistons or forged steel connecting rods are being used, install them into the cylinder from which they were removed.
- The connecting rod bearing tangs are always oriented toward the outside of the engine block.



Connecting rod bearing tangs

- The notch on the top of the piston must be positioned toward the front of the engine (water pump end).



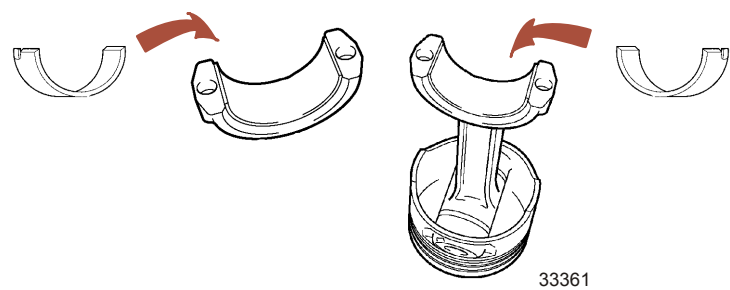
a - Piston notch

1. Cylinder bore preparation:
 - a. Clean the cylinder bores with a light honing oil, as necessary.
 - b. Clean with hot water and detergent.
 - c. Rinse thoroughly.
 - d. Lightly oil the cylinder bores with a clean, lint free white cloth, with engine oil. Repeat until the cloth remains clean.
 - e. Wipe down the cylinder bores a final time with a clean, lint free white cloth.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Cylinder walls	Obtain Locally

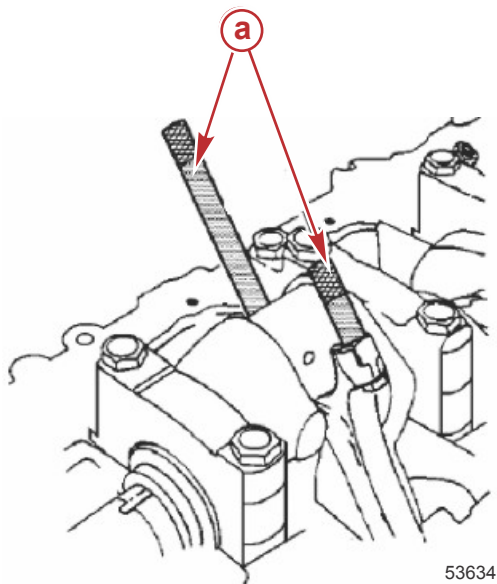
2. Rotate the crankshaft until the crankpin is at before dead center (BDC) for the cylinder that is ready for the first piston to be installed.
3. Carefully wipe any foreign material from the connecting rod bearings and the connecting rod bearing fitting surfaces.
IMPORTANT: Do not apply oil to the back of the bearings or the connecting rod bearing mating surfaces.

4. Insert the bearing shells into the connecting rod and its matching rod cap.



5. Liberally lubricate the connecting rod bearings, pistons, rings, and cylinder walls.

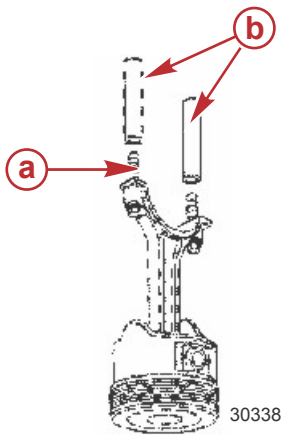
Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Connecting rod bearings, pistons, rings, and cylinder walls	Obtain Locally



a - Connecting rod screw guides (J5239)

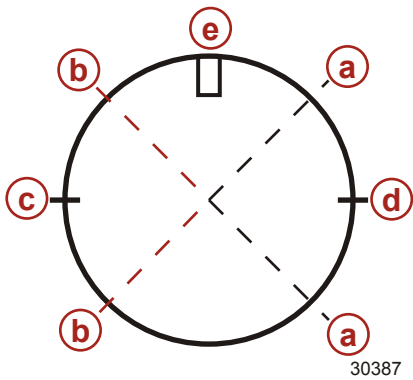
6. With the bearing caps removed, install the connecting rod screw guides onto the connecting rod screws. It is acceptable to use clean rubber tubing for the connecting rod screw guides.

Description	Part Number
Connecting rod screw guide	J5239



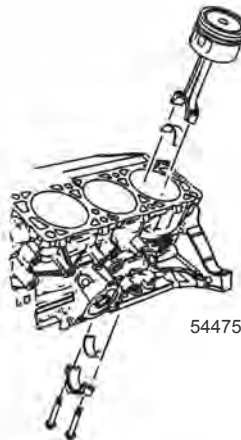
Forged steel rod
a - Connecting rod screw (2)
b - Screw guides (2)

7. Position ring gaps as shown.



- Ring gap locations**
- a** - Oil ring spacer gap
 - b** - Oil ring gaps
 - c** - Lower compression ring gap
 - d** - Upper compression ring gap
 - e** - Front of engine

8. Use the piston ring compressor and compress rings.



Powder metal rod

30399

Piston ring compressor use

Description	Part Number
Piston ring compressor	J8037

IMPORTANT: Be sure to install new pistons in the same cylinders for which they were fitted and used pistons in the same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at the front of engine (1, 3, and 5 from the left bank and 2, 4, and 6 from the right bank). Numbers on connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with new cylinder number.

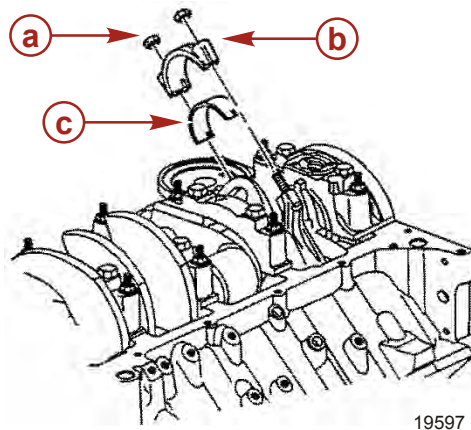
- 9. Install each connecting rod and piston assembly in its respective bore with the connecting rod bearing tangs toward the outside of the engine block and the piston notch toward the front of the engine.
- 10. Hold the piston ring compressor firmly against the engine block until all piston rings have entered the cylinder bore.
- 11. Using a wooden or plastic hammer handle, lightly tap the piston into its bore.
- 12. Apply a lubricant to the threads and mating faces of each connecting rod cap and screw.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Threads and mating faces of connecting rod cap and screws	Obtain Locally

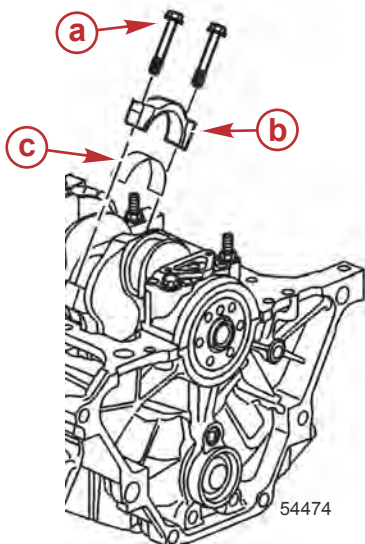
NOTICE

Connecting rods and end caps are matched sets. Mismatching the original pairs will result in catastrophic engine damage. Install all connecting rods with their matched end caps.

- 13. Install the connecting rod cap.



- Installing connecting rod caps (forged steel)**
- a** - Connecting rod nuts (2)
 - b** - Connecting rod cap
 - c** - Lower bearing half

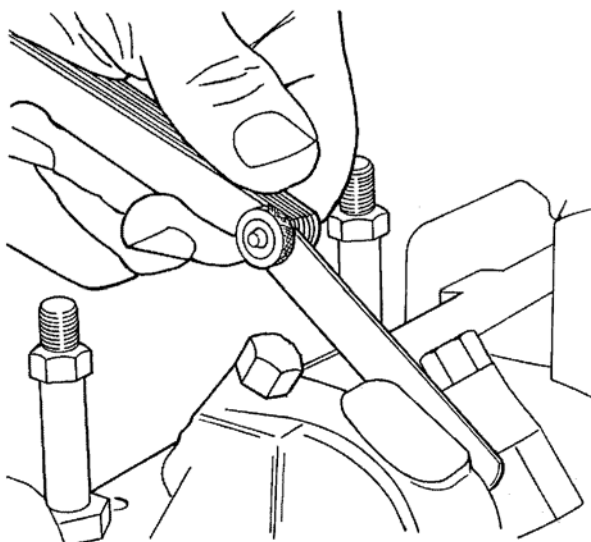


- Installing connecting rod caps (powder metal)**
- a** - Connecting rod screws (2)
 - b** - Connecting rod cap
 - c** - Lower bearing half

- 14. In a two pass sequence, tighten connecting rod cap screws to the specified torque.

Description		Nm	lb-in.	lb-ft
Connecting rod nut (forged steel)	First	27	–	20
	Final	+ 70°		
Connecting rod bolt (powder metal)	First	20	177	–
	Final	+ 100°		

15. Lightly tap each connecting rod assembly parallel to the crankpin to set side clearance.
16. Check rod bearing clearance using plastic gauge method. Refer to **Connecting Rod Bearing Clearance, Plastic Gauge Method**.
17. Measure all connecting rod side clearances between the connecting rod caps.



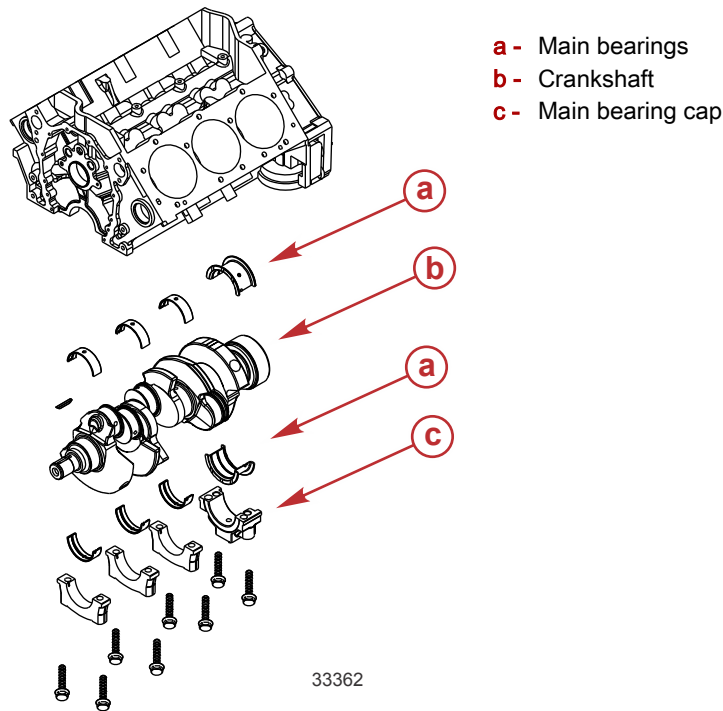
6408

Measuring connecting rod side clearance

Description	4.3 Liter (262 cid)
Rod side clearance	0.15–0.44 mm (0.0059–0.017 in.)

18. Install the oil pump and crankshaft oil deflector. Refer to **Oil Pump**.
19. Install the dipstick and oil pan. Refer to **Oil Pan**.
20. Install the cylinder heads. Refer to **Cylinder Head**.
21. Install the intake manifold assembly. Refer to **Upper and Lower Intake Manifolds**.
22. Install the distributor. Refer to **Section 4B**.
23. Adjust the valves. Refer to **Rocker Arms and Valve Pushrods**.
24. Install the valve covers. Refer to **Valve Cover**.
25. Install the exhaust elbow and manifold assemblies. Refer to **Section 7**.
26. Fill the crankcase with the proper viscosity and quantity of oil. Refer to **Section 1C**.
27. Install all other external components removed from the front of the engine.

Crankshaft, Main Bearings, and Engine Block Exploded View



Removal

If only the main bearings are being serviced, refer to **Main Bearing installation** of this section of the service manual.

NOTE: Engine port and starboard cylinder heads are removed for illustration clarity.

1. Disconnect all electrical connections to the engine.
2. Disconnect the throttle and shift remote control cables (if equipped). Refer to **Section 2A**.
3. Remove the sterndrive.
4. Drain the seawater and closed cooling systems. Refer to **Section 1C**.
5. Remove the engine from the boat. Refer to **Section 2**.
6. Mount the engine on a suitable engine stand.
7. Drain the engine oil.
8. Remove the starter. Refer to **Section 4A**.
9. Remove the flywheel housing. Refer to **Flywheel Housing**.
10. Remove the coupler or drive plate. Refer to **Flywheel**.
11. Remove the flywheel.
12. Remove the water circulating pump.
13. Remove the crankshaft pulley and the crankshaft balancer. Refer to **Crankshaft Balancer**.
14. Remove the spark plugs. Refer to **Section 4B**.
15. Remove the dipstick tube and oil pan. Refer to **Oil Pan**.
16. Remove the crankshaft oil deflector and oil pump. Refer to **Oil Pump**.
17. Remove the crankshaft position sensor. Refer to **Crankcase Front Engine Cover**. Discard the O-ring seal.
18. Remove the engine front cover. Refer to **Crankcase Front Engine Cover—Removal**.
19. Remove the crankshaft position sensor tone-ring. Refer to **Camshaft, Camshaft Bearing, and Balance Shaft**.
20. Remove the camshaft sprocket. Refer to **Camshaft, Camshaft Bearing, and Balance Shaft**.

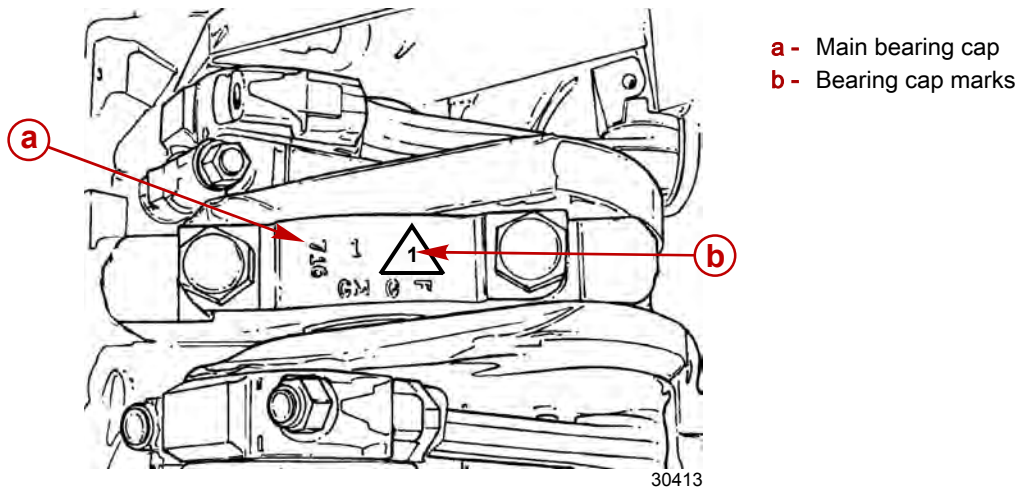
NOTE: If the sprocket does not come off easily, lightly tap on the lower edge of the sprocket with a plastic mallet to dislodge it.

21. Remove the timing chain. Refer to **Timing Chain and Sprockets**.
22. Remove the rear main seal retainer and seal.

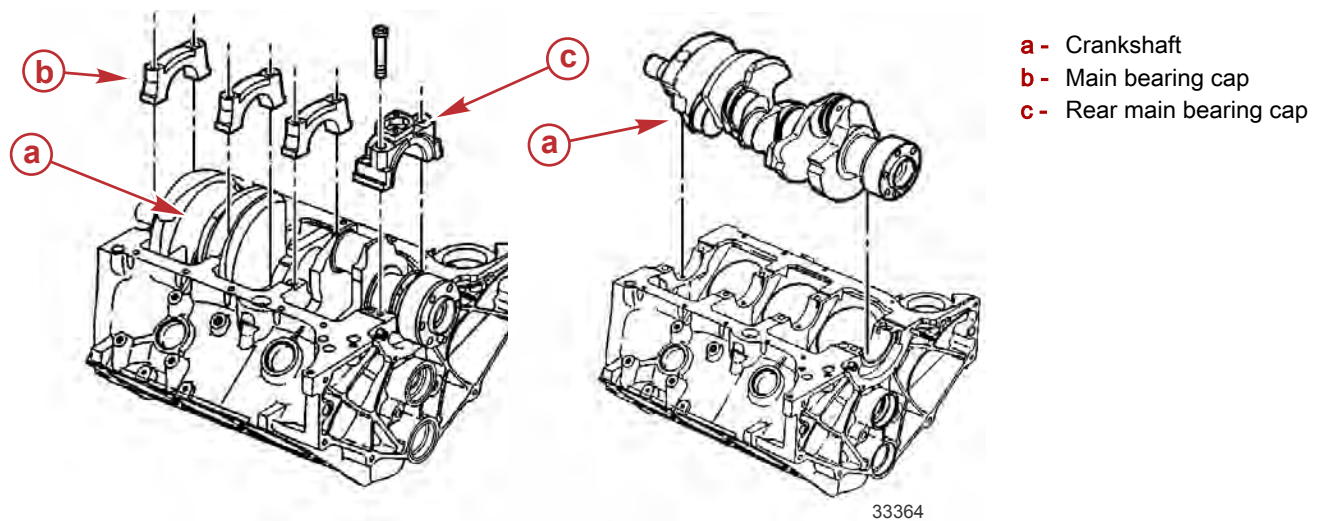
23. Remove the connecting rod and piston assemblies.

IMPORTANT: Inspect the bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be installed in their original locations.

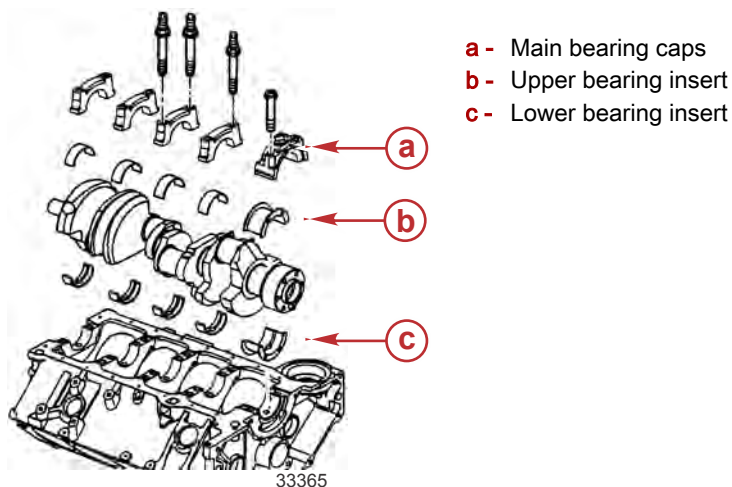
24. Ensure that all bearing caps are marked so that they can be installed in their original locations.



25. Remove the main bearing caps and carefully lift the crankshaft out of the engine block.



26. If new main or connecting rod bearings are to be installed, remove the main bearing inserts from the engine block and the bearing caps or connecting rod bearing inserts from the connecting rods and caps. Install new bearings.



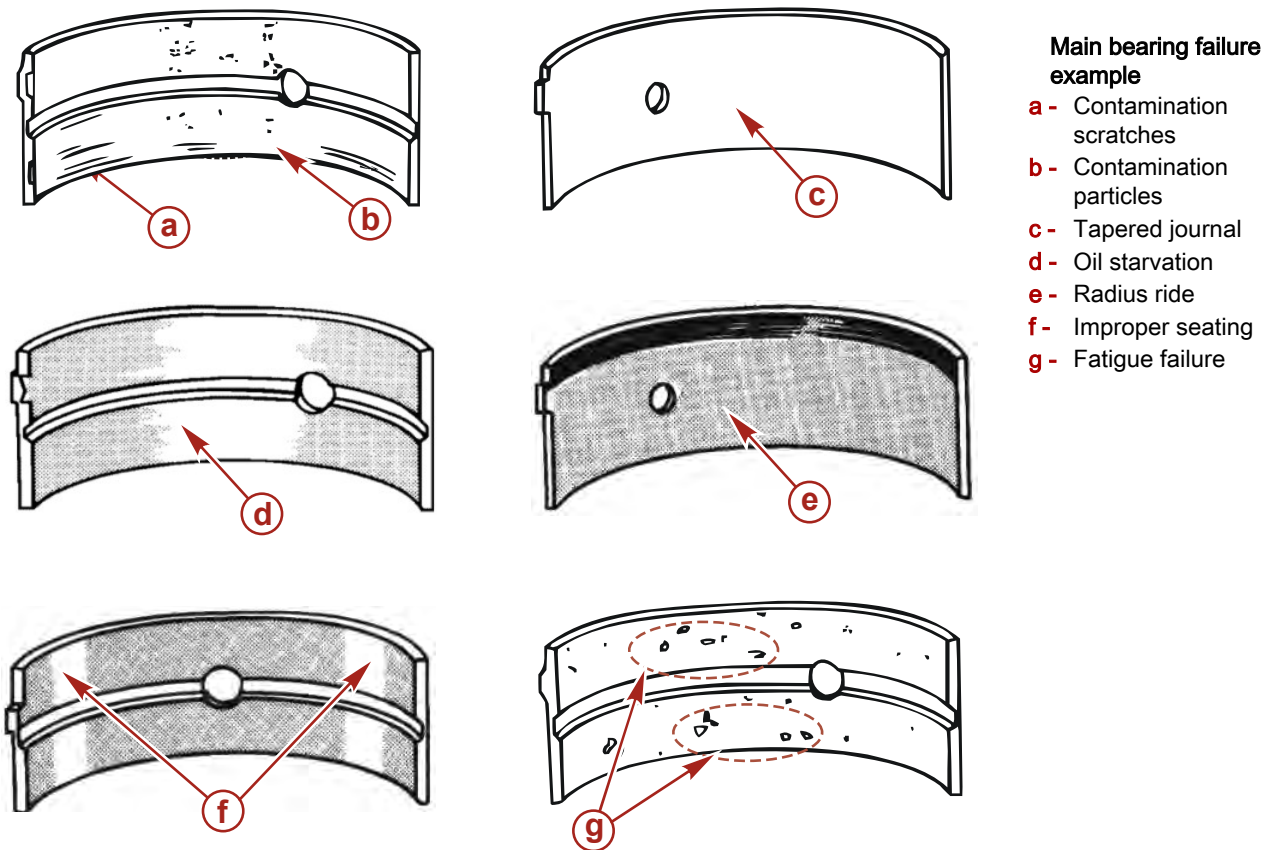
Main Bearing Inspection

This MerCruiser engine uses precision insert type main bearings. If installed bearing clearance exceeds specification then the bearing assembly must be replaced. Service bearings are available in standard size and 0.0254 mm (0.001 in.), 0.254 mm (0.010 in.) and 0.508 mm (0.020 in.) undersized.

Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For this reason you may find 1/2 of a standard insert with 1/2 of a 0.0254 mm (0.001 in.) undersized insert, which will decrease the clearance 0.0127 mm (0.0005 in.) over using a complete standard size bearing set.

When a production crankshaft cannot be precision fitted by this method, it is then ground 0.229 mm (.009 in.) undersized, on only those main journals that cannot be properly fitted. All journals will not necessarily be ground undersized. A 0.229 mm (0.009 in.) undersized bearing and 0.254 mm (0.010 in.) undersized bearing may be used for precision fitting in the same manner as previously described.

Due to loading factors, the lower half of a crankshaft bearing set will generally exhibit the most wear. If inspection indicates the lower bearing half is suitable for reuse, it can be assumed that the upper bearing half can also be reused. If the lower bearing half shows evidence of wear or damage, replace the entire bearing set. Never replace one half of a bearing set without replacing the other half.



6354

Cleaning

Crankshaft

1. Clean the crankshaft in cleaning solvent. Ensure oil passages are clear of sludge and restriction.
2. Dry with compressed air.

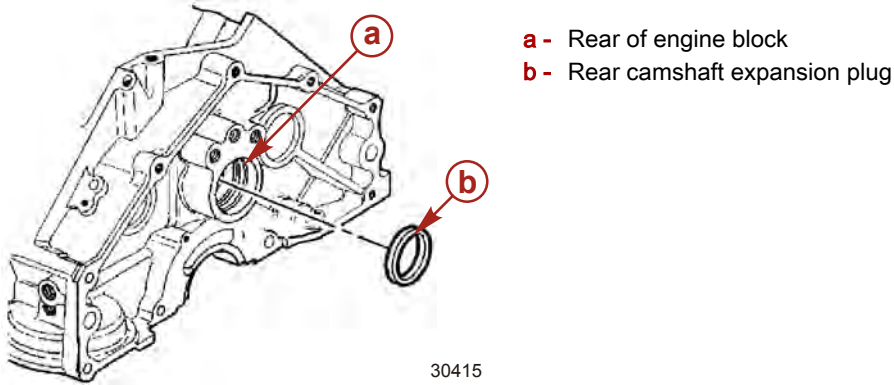
Main Bearings

1. Clean the crankshaft bearings in cleaning solvent. Wipe the crankshaft bearings clean with a soft cloth, do not scratch the crankshaft bearing surfaces.
2. Dry parts with compressed air.

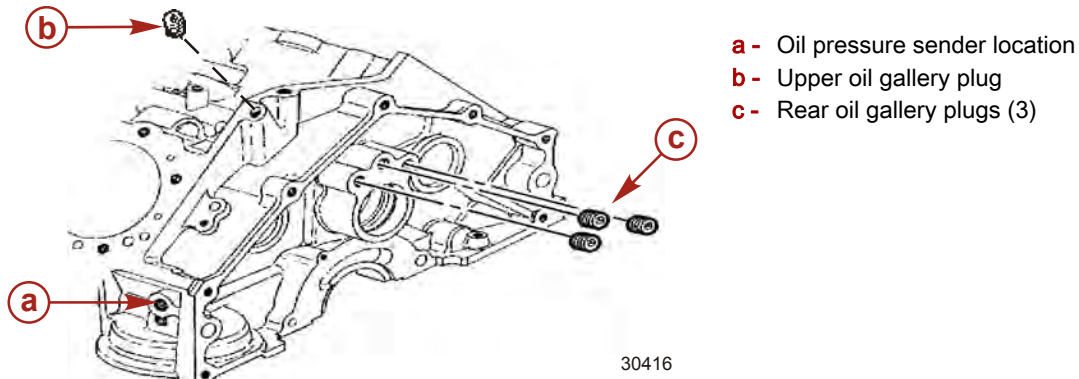
Engine Block

1. Remove all engine components.

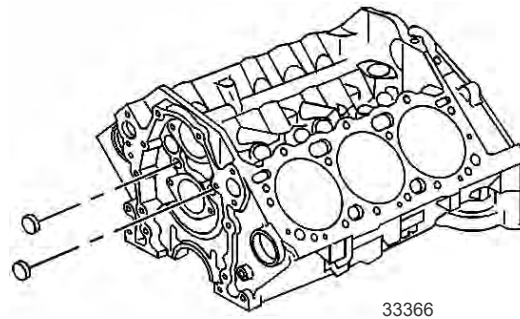
2. Remove the camshaft rear bearing hole expansion cup plug.



3. Remove the oil pressure sender and oil gallery plugs.

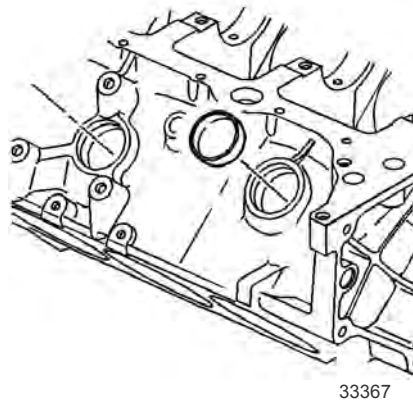


4. Insert a 3/8 in. x 26 in. rod into the rear oil gallery holes and drive out (remove) the front oil gallery plugs. Discard the plugs.



NOTE: Expansion plugs may be removed with a sharp punch or drilled and pried out.

5. Remove and discard the engine block core hole expansion plugs.



6. Clean all sealing surfaces.

7. Remove all gasket and sealant residue.
8. Clean the engine block with cleaning solvent.
9. Flush the engine block with clean water or steam clean.
10. Clean the cylinder bores.
11. Clean the oil galleries and oil passages.
12. Clean scale and deposits from the coolant passages.
13. Clean the engine block cylinder head bolt holes and dry with compressed air.
14. After cleaning the engine block, spray or wipe the cylinder bores and other machined surfaces with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Cylinder bores and other machined surfaces	Obtain Locally

Crankshaft Inspection

1. Inspect the machined surfaces of the crankshaft for deep grooves, scratches, pitted surfaces, or uneven wear.
2. Inspect the crankshaft rear oil seal surface for scoring or damage.
3. Inspect the crankshaft oil passages for restrictions.
4. Inspect the thrust journal surface for wear or damage.
5. Inspect the crankshaft threaded bolt holes for damage.
6. Inspect the crankshaft balancer keyway for damage.
7. Measure the main bearing journals with a micrometer for out of round, taper, and undersized diameter.
IMPORTANT: The crankshaft journal diameter must be measured in multiple locations approximately 90° apart. Average the resulting measurements for comparison to specification.

Description		4.3 Liter (262 cid)
Diameter	Number 1	62.199–62.217 mm (2.4488–2.4495 in.)
	Number 2, 3	62.191–62.215 mm (2.4485–2.4494 in.)
	Number 4	62.179–62.203 mm (2.4480–2.4489 in.)

Description		4.3 liter (262 cid)
Taper	Production	0.007 mm (0.0003 in.) maximum
Out of round	Production	0.005 mm (0.0002 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

8. Measure the connecting rod bearing journals with a micrometer for out of round, taper, and undersized diameter.

Description		4.3 Liter (262 cid)
Diameter		57.116–57.148 mm (2.2487–2.2497 in.)
Taper	Production	0.0050 mm (0.0002 in.) maximum
	Service limit	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.007 mm (0.0003 in.) maximum
	Service	0.0025 mm (0.0010 in.) maximum

9. To check the crankshaft for runout, support the front and rear main bearings journals in V-blocks.
10. Check crankshaft runout at the front and rear intermediate journals with a dial indicator.

Description	4.3 liter (262 cid)
Runout	0.0025 mm (0.0010 in.)

11. Replace or recondition the crankshaft if not within specifications.

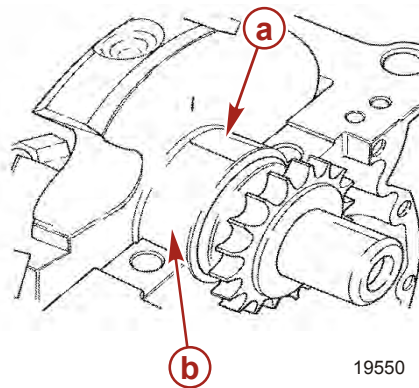
Main Bearing Clearance, Plastic Gauge Method

To obtain accurate measurements while using Plastigauge or its equivalent, the engine must be out of the boat and upside down so the crankshaft will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal.

To ensure the proper seating of the crankshaft, all bearing cap bolts should be at specified torque. In addition, the surface of the crankshaft journal and bearing must be wiped clean of oil.

NOTE: When checking the number 1 main bearing, loosen the accessory drive belt to prevent obtaining a tapered reading with the gauging plastic.

1. Remove the bearing cap and wipe any oil from the journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing and parallel to the crankshaft centerline as shown.



Main bearing plastic gauge measurement

- a -** Gauging plastic
b - Bearing journal

IMPORTANT: The bearing caps must be tightened to the specified torque to ensure correct measurements. Do not rotate the crankshaft with the plastic gauge installed.

3. Install the bearing cap and evenly tighten the main bearing cap bolt or stud to the specified torque.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud, preferred method	First	20	177	–
	Final	+ 73°		

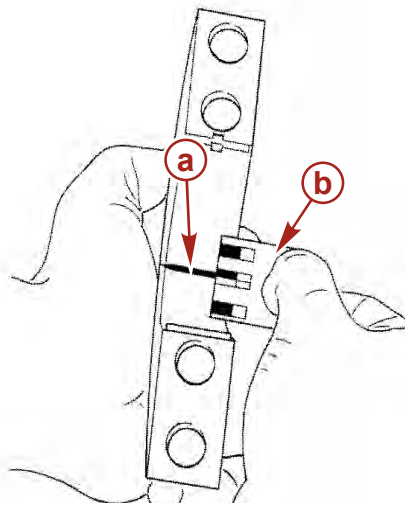
Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud, optional method		105	–	77

4. Remove the bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or the journal.
5. On the edge of the gauging plastic envelope there is a graduated scale that is correlated in thousandths of an inch. Without removing the gauging plastic from the crankshaft bearing or journal, measure its compressed width at the widest point with the graduated scale.

NOTE: Normally main bearing journals wear evenly and are not out of round.

- If a bearing is being fitted to an out of round journal of 0.0254 mm (0.001 in.) maximum, be sure to fit to the maximum diameter of the journal.
- If the bearing is fitted to the minimum diameter and the journal is out of round 0.0254 mm (0.001 in.) maximum, interference between the bearing and journal will result in rapid bearing failure.
- If the flattened gauging plastic tapers toward the middle or ends, the difference in clearance indicates taper or an other irregularity of the bearing or journal.

- Measure the journal with a micrometer if the flattened gauging plastic indicates more than 0.0254 mm (0.001 in.) difference.



Measuring clearance with plastic gauge

- a** - Compressed gauging plastic
b - Scale

19552

Main Bearing Clearance		
Description		4.3 Liter (262 cid)
Production	Number 1	0.018–0.053 mm (0.0007–0.0021 in.)
	Number 2, 3, 4	0.030–0.068 mm (0.0012–0.0027 in.)
	Number 5	0.020–0.060 mm (0.0008–0.0024 in.)
Service	Number 1	0.025–0.051 mm (0.0010–0.0020 in.)
	Number 2, 3, 4	0.025–0.064 mm (0.0010–0.0025 in.)
	Number 5	0.038–0.063 mm (0.0015–0.0025 in.)

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a set.
7. A standard or 0.025 mm (0.001 in.) undersized bearing may produce the proper clearance. If not, it will be necessary to grind the crankshaft journal for use with the next undersized bearing.
IMPORTANT: After selecting a new bearing, recheck clearance.
8. Check clearance with a newly selected bearing. If the bearing clearance is within specifications, the bearing insert is satisfactory. If not, repeat previous steps.
9. Proceed to the next bearing. After all bearings have been checked, oil and install the selected bearings and rotate the crankshaft to check for excessive drag.

Crankshaft End Play

1. Firmly force the crankshaft rearward.
2. Firmly force the crankshaft forward.

3. Measure the clearance at the front end of the rear main bearing with a feeler gauge as shown.

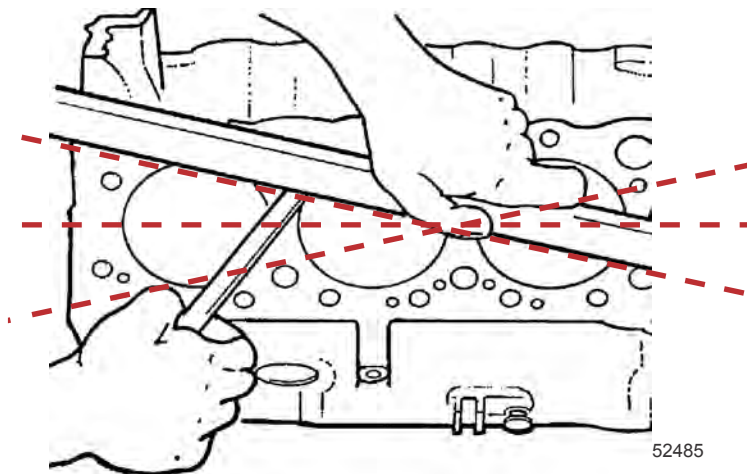
19553

Measuring crankshaft end play

Description	4.3 Liter (262 cid)
End play (thrust clearance)	0.05–0.20 mm (0.0020–0.0079 in.)

Engine Block Inspection

1. Inspect the engine block for cracks in coolant jackets.
2. Inspect the cylinder bores for scratches or gouging.
3. Inspect the valve lifter bores for excessive scoring or wear.
4. Inspect the threaded holes, crankshaft bearing caps, bearing bores, and engine block core hole expansion plug bores for damage.
5. Inspect the engine block, engine mount bosses and crankshaft bearing webs for cracks or damage.
6. Check the engine block head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across the surface (both ways) and straight down center. If warp exceeds specification, the engine block must be resurfaced by a machine shop.

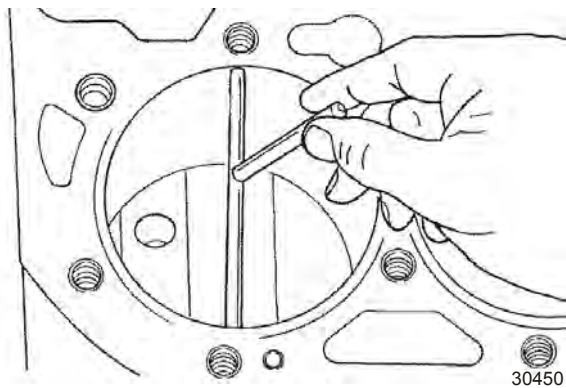


Checking engine block head gasket surfaces for warp

Description		4.3 Liter (262 cid)
Surface flatness	At engine block deck with an 152 mm (6.0 in.) area	0.10 mm (0.0040 in.)

7. Check the cylinder bore:

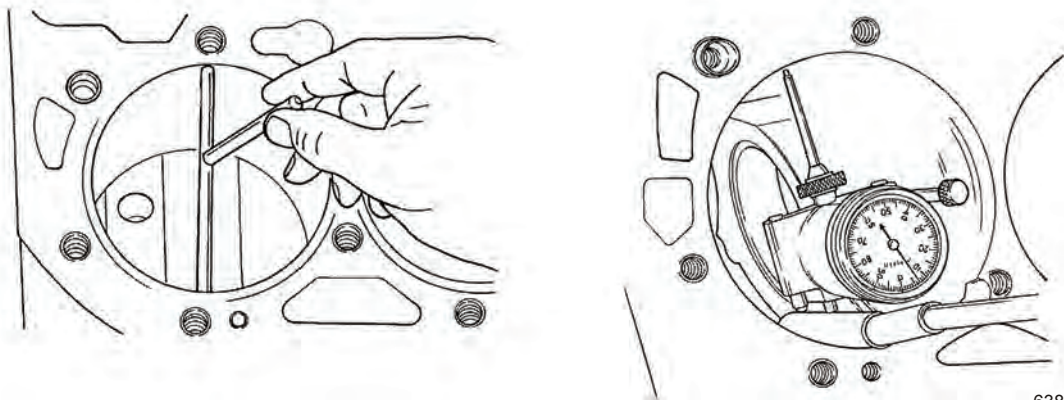
- a. Measure cylinder bore diameter with a dial indicator or inside micrometer.



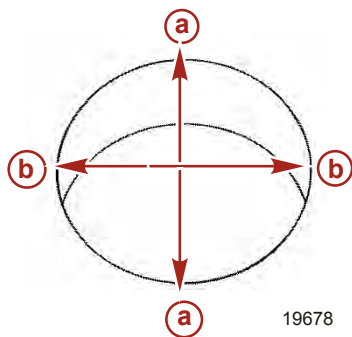
Measuring cylinder bore

Description	4.3 Liter (262 cid)
Diameter	94.894–94.947 mm (3.7360–3.7381 in.)

- b. Measure cylinder bore taper with a dial indicator or inside micrometer, measuring the diameter at the top and bottom of the cylinder at positions "a" and "b." Cylinder taper will be the difference between the top and bottom measurements.
- c. Measure cylinder out of round with a dial indicator or inside micrometer, measuring the diameter at positions "a" and "b." Cylinder out of round is the difference between the two measurements.



Measuring cylinder out of round



- a - At a right angle to the centerline of engine
- b - Parallel to the centerline of engine

Description		4.3 Liter (262 cid)
Out of round	Production	0.0127 mm (0.0005 in.) maximum
	Service	0.05 mm (0.0020 in.)
Taper	Production—thrust side	0.013 mm (0.0005 in.) maximum
	Production—relief side	0.025 mm (0.0010 in.) maximum
	Service	0.025 mm (0.0010 in.) over production

- d. Remove any ridge at the top of ring travel.
8. If the cylinder does not meet specifications, honing, or boring and honing will be necessary.

Cylinder Reconditioning

NOTE: The effectiveness of cylinder reconditioning depends upon engine condition at time of repair.

NOTE: If engine block inspection indicates that the block is suitable for continued service, out of round, or tapered cylinders can be reconditioned by honing or boring and honing.

1. If cylinders have less than 0.127 mm (0.005 in.) wear, they can be reconditioned with a hone and fitted with high limit standard size pistons. If there is more than 0.127 mm (0.005 in.) wear, bore and hone to fit the smallest oversized piston that will permit the complete resurfacing of all cylinders.
2. Clean cylinder bores with hot soapy water. Rinse thoroughly. After cleaning, lightly lubricate the cylinder walls with engine oil and a clean cloth. Wipe off excess oil with a clean dry cloth.

Cylinder Boring

IMPORTANT: Before using any type of boring bar, file the top of the engine block to remove dirt or burrs. This prevents boring bar tilt (the bored cylinder wall is not at right angles to crankshaft).

1. File the top of the engine block to smooth any irregular surface and remove any deposits or burrs.
2. Clean the cylinders with warm water and detergent. Rinse thoroughly.
3. Measure the piston to be fitted with a micrometer. Take measurements at the center of the piston skirt and at right angles to the piston pin.

NOTE: Hone cylinders as outlined under **Cylinder Honing and Piston Selection**.

4. Bore the cylinder to same diameter as the piston and hone to provide the specified clearance.
5. Carefully observe equipment manufacturer's instructions.

Cylinder Honing

1. Follow the instructions provided with the cylinder hone kit.

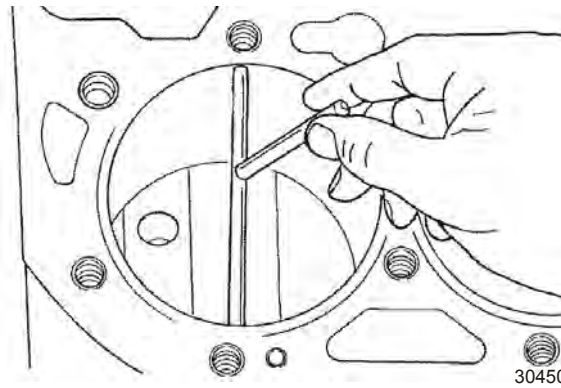
Description	Part Number
Kent-Moore cylinder hone tool kit	J5902-01

2. Frequently clean the cylinder bore and recheck piston for a correct fit in the cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a 30 degree cross hatch pattern. Finish marks should be clean but not sharp, free from imbedded particles, torn or folded metal.
4. As each piston is fitted to a cylinder, permanently mark each with its corresponding cylinder number.
IMPORTANT: Handle pistons with care and do not attempt to force them into a cylinder until it is honed to the correct size.
5. Thoroughly clean cylinder bores with hot soapy water. Scrub each cylinder with a stiff, synthetic bristle brush, and rinse thoroughly with hot water. Lightly lubricate the cylinders with light engine oil on a clean cloth, then wipe clean with a clean dry cloth. Repeat this process several times until the oiled cloth remains clean and free of machining debris. The cylinder should not be cleaned with kerosene or gasoline. Clean the engine block to remove dirt and debris left by the reconditioning process.

Piston Selection

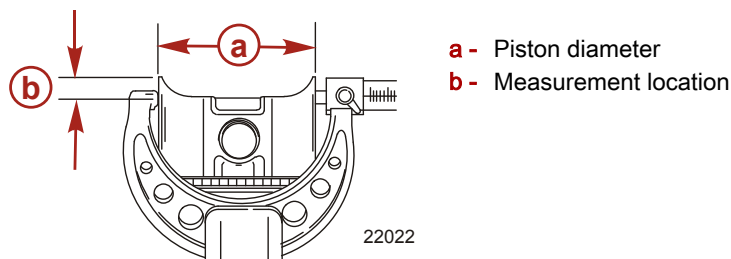
1. Check used piston to cylinder bore clearance:

- a. Measure the cylinder bore diameter with a telescope gauge 64 mm (2.5 in.) from top of the cylinder bore.



Measuring cylinder bore diameter

- b. Measure the piston diameter at the skirt 11 mm (0.4331 in.) from the bottom of the skirt at a right angle to the piston pin bore.



- c. Subtract the piston diameter from the cylinder bore diameter to determine piston to bore clearance.
- d. Determine if the piston to bore clearance is in acceptable range.

Description	4.3 Liter (262 cid)
Production	0.018–0.061 mm (0.0007–0.0024 in.)
Service	0.075 mm (0.0029 in.) maximum

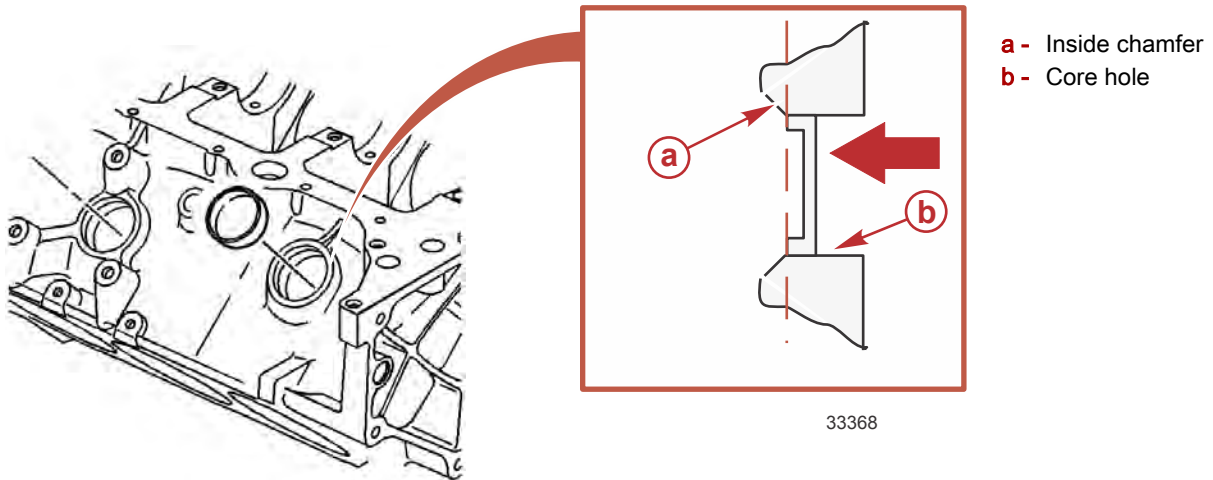
2. If a used piston is not satisfactory, determine if a new piston can be selected to fit the cylinder bore within the specified range.
3. If the cylinder bore must be reconditioned, measure new piston diameter, then hone cylinder bore to correct clearance.
4. Mark each piston to identify cylinder for which it was fitted.

Installation

Engine Block Plugs

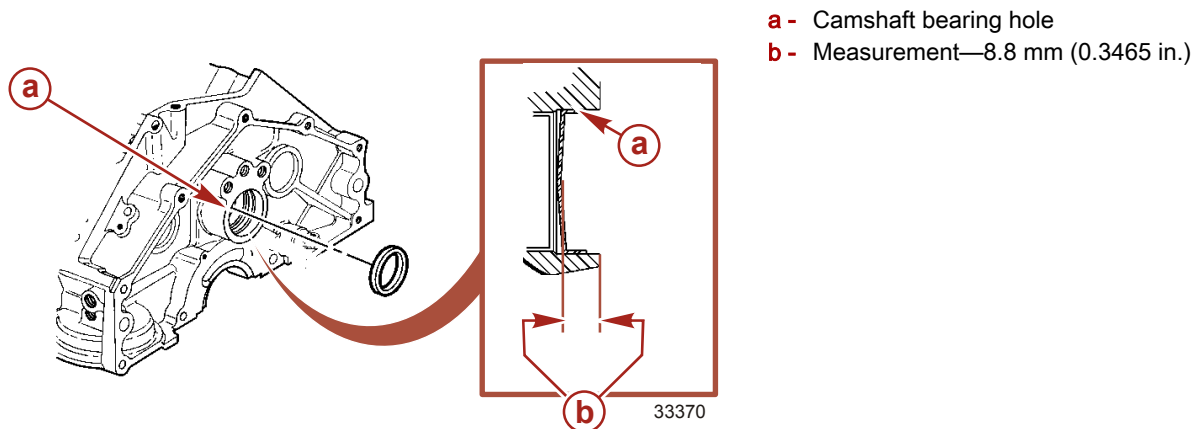
1. Put on safety glasses.
2. Apply sealant to the outside diameter of each new engine block core hole expansion plugs.

3. Install engine block core hole expansion plugs flush with the inside chamfer of the engine block core hole.



Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Outside diameter of engine block core hole expansion plug	92-809821

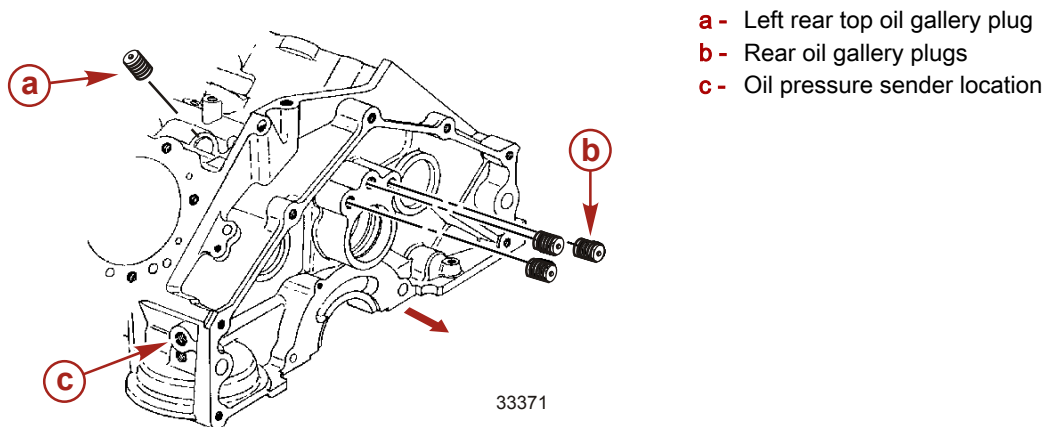
4. Apply sealant to the outside diameter of the new camshaft rear bearing hole expansion cup plug.
5. Install the camshaft rear bearing hole expansion cup plug as indicated.



Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Outside diameter of camshaft rear bearing hole expansion cup plug	92-809821

6. Apply sealant to the threads of the oil pressure sender and oil gallery plugs.

7. Install the oil pressure sender and oil gallery plugs indicated.



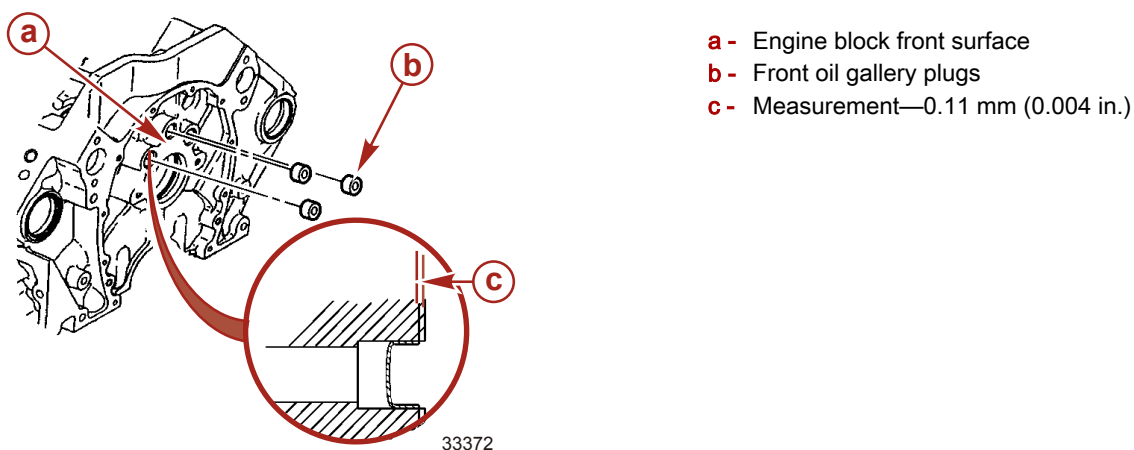
Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of oil gallery plugs and oil pressure sender	Obtain Locally

Description	Nm	lb-in.	lb-ft
Oil gallery plug	20	177	–

8. Coat the threads of the new engine block oil gallery plugs.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of the oil gallery plug	Obtain Locally

9. Install the front oil gallery plugs less than flush with engine block front surface as indicated.



10. Coat the threads of the engine block coolant drain plugs.

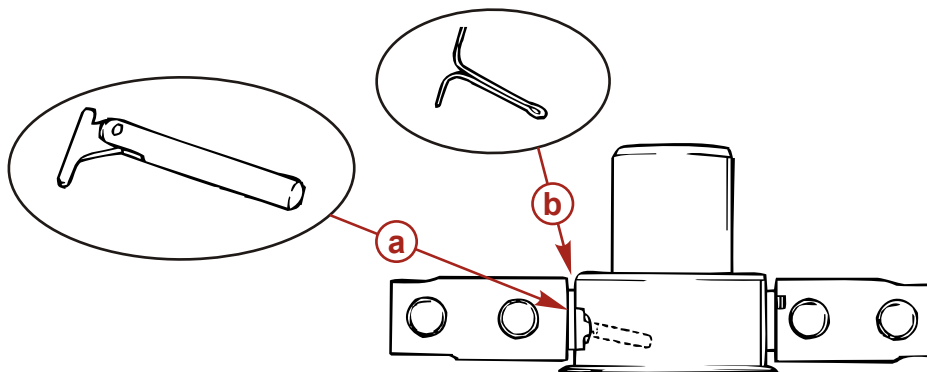
Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of the engine block coolant drain hole plug	Obtain Locally

11. Install the engine block coolant drain hole plugs. Tighten the plugs to the specified torque.

Description	Nm	lb-in.	lb-ft
Engine block coolant drain hole plug	20	177	–

Main Bearings, Without Crankshaft Removed

1. Remove the cap on the main bearing requiring replacement.
2. Remove the bearing from the cap.
3. Install the main bearing remover and installer tool in the oil hole in the crankshaft journal. If this tool is not available, a cotter pin may be bent as shown and used.



a - Main bearing remover and installer tool

b - Cotter pin

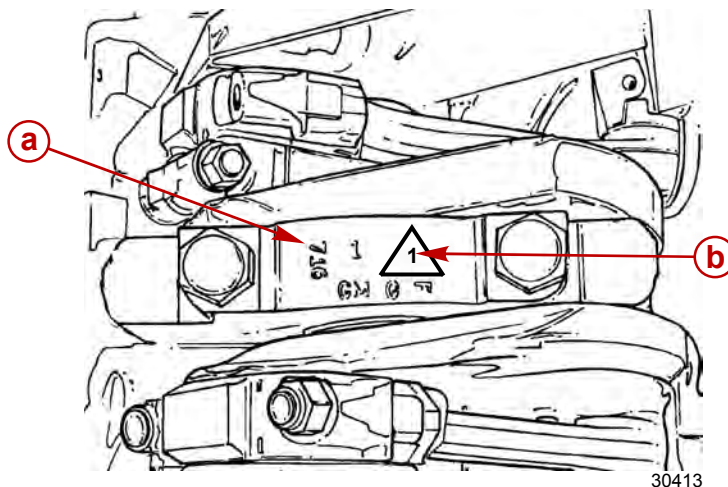
6379

Description	Part Number
Kent-Moore main bearing remover and installer tool	J8080

4. Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll the upper bearing out of the engine block.
5. Lubricate a new upper bearing.
6. Insert the plain (unnotched) end between the crankshaft and the indented or notched side of the engine block.
7. Rotate the bearing into place and remove the tool from the oil hole in the crankshaft journal.
8. Lubricate a new lower bearing and install in the bearing cap.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Upper and lower bearing	Obtain Locally

9. Install the main bearing cap in the original location with the markings pointing toward the front of the engine.



a - Main bearing cap

b - Bearing cap marks

30413

10. Tighten all main bearing caps, except the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud—preferred method	First	20	177	—
	Final	+73°		

Description	Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud—optional method	105	–	77

11. Tighten the rear main bearing cap. Using one of the methods described below.

Preferred Method:

1. Do the first step torque on the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud—preferred method	First	20	177	–

2. Using a lead hammer, tap the end of the crankshaft to the rear.
 3. Using a lead hammer, tap the end of the crankshaft to the front.
 4. Do the final step torque on the bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud—preferred method	Final	+73°		

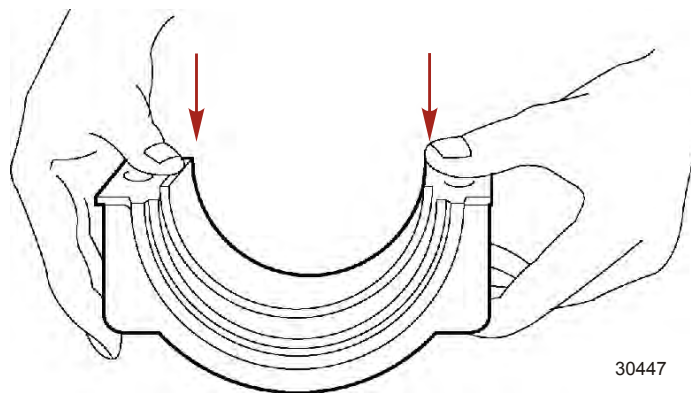
Optional Method:

1. Tap the end of the crankshaft to the rear and then to the front with a lead hammer.
 2. Evenly tighten the rear main bearing cap.

Description	Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud—optional method	105	–	77

Main Bearing Tension

IMPORTANT: Ensure that the main bearing is installed under tension. It should require firm pressure to fit the bearing into position.



30447

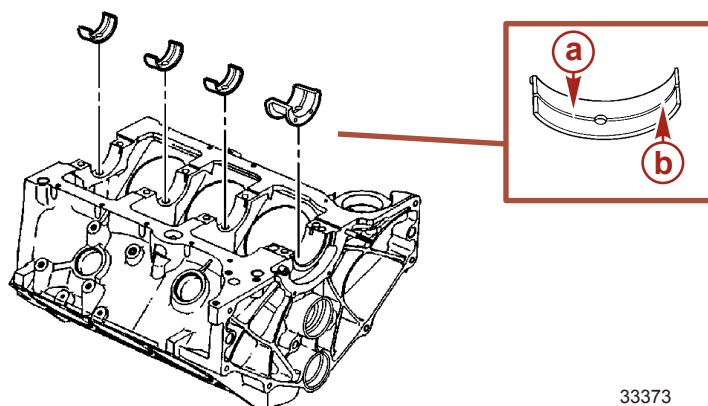
Main bearing tension

Main Bearings and Crankshaft

1. Remove the timing sprocket from the old crankshaft and install on the new crankshaft.
2. On the driveshaft extension models—If the old pilot bushing is to be reused, the bushing can be removed without damage as follows:
 - a. Fill the pilot bushing cavity with grease.
 - b. Insert an old transmission input shaft in the bore of the bushing and hit it with a hammer. This will create hydraulic pressure in the pilot bushing cavity that should force the bushing out.

IMPORTANT: Ensure that all bearings and crankshaft journals are clean.

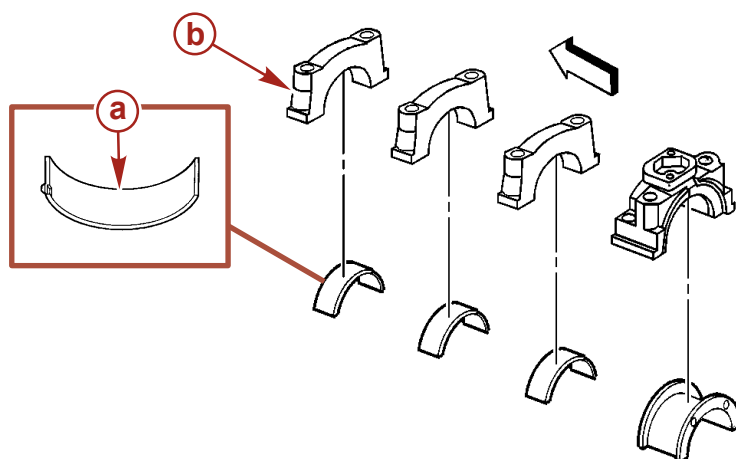
3. Install the upper main bearing inserts in the engine block.



- a** - Upper insert
- b** - Oil groove

33373

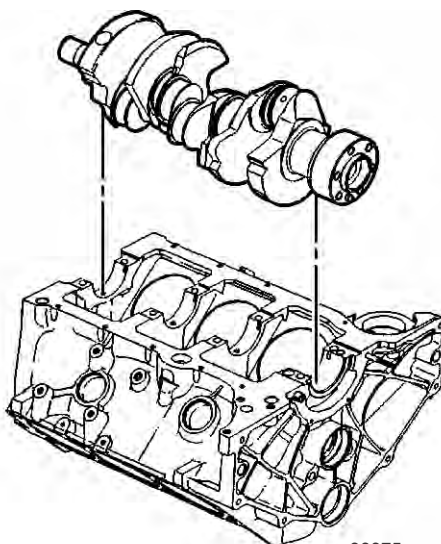
4. Install the lower main bearing insert into the main bearing caps.



- a** - Lower insert
- b** - Main bearing cap

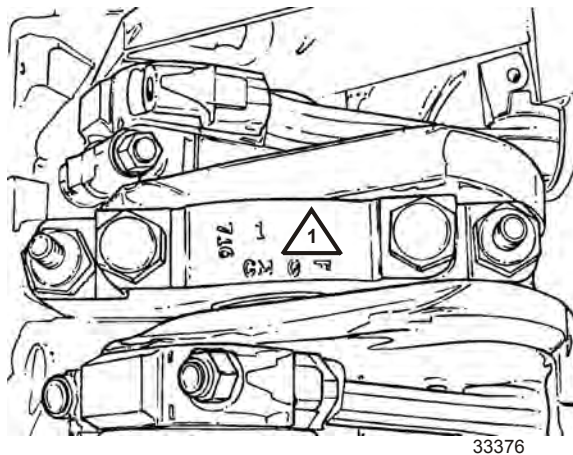
33374

5. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.



33375

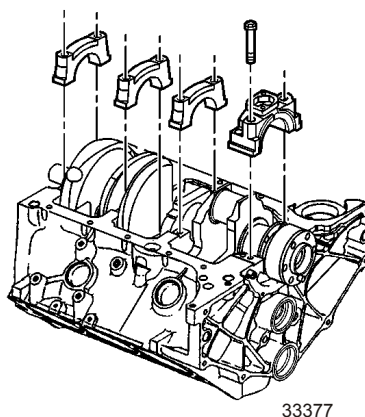
6. Install the main bearing caps in the original location with the markings pointing toward the front of the engine.



7. Check the clearance of each main bearing, following procedure outlined under **Inspection—Main Bearing Clearance**.
 8. When bearing clearances meet specifications, lubricate the main bearings and crankshaft bearing journals.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Main bearings and crankshaft bearing journals	Obtain Locally

9. Install the main bearing caps.



10. Check main bearing clearance using Plastigauge. Refer to **Main Bearing Clearance, Plastic Gauge Method**.
 11. Tighten all main bearing caps, except the rear main cap, to the specified torque.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud—preferred method	First	20	177	–
	Final	+73°		

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud—optional method		105	–	77

12. Tighten the rear main bearing cap. Using one of the following methods:
 a. **Preferred method:** Do the first step torque on the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud—preferred method	First	20	177	–

- b. Using a lead hammer, tap the end of the crankshaft to the rear.
- c. Using a lead hammer, tap the end of the crankshaft to the front.
- d. Do the final step torque on the bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud—preferred method	Final	+73°		

- a. **Optional method:** Tap the end of the crankshaft to the rear and then to the front with a lead hammer.
- b. Evenly tighten the rear main bearing cap to the specified torque.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud—optional method		105	–	77

13. Tighten the rear main bearing cap to the specified torque.
14. Check the crankshaft end play.
15. Install the rear main seal retainer and seal.
16. Check the clearance for each connecting rod bearing, following the procedure under **Connecting Rod, Bearings, and Piston Assembly—Preliminary Inspection**.
17. If the bearing clearances are satisfactory, coat the connecting rod bearing surface with lubricant.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Connecting rod bearing surfaces	Obtain Locally

18. Install the connecting rod cap.
19. In a two step sequence, tighten the connecting rod cap nuts to the specified torque.

Description		Nm	lb-in.	lb-ft
Connecting rod nut—4.3 Liter (262 cid)	First	27	–	20
	Final	+70°		

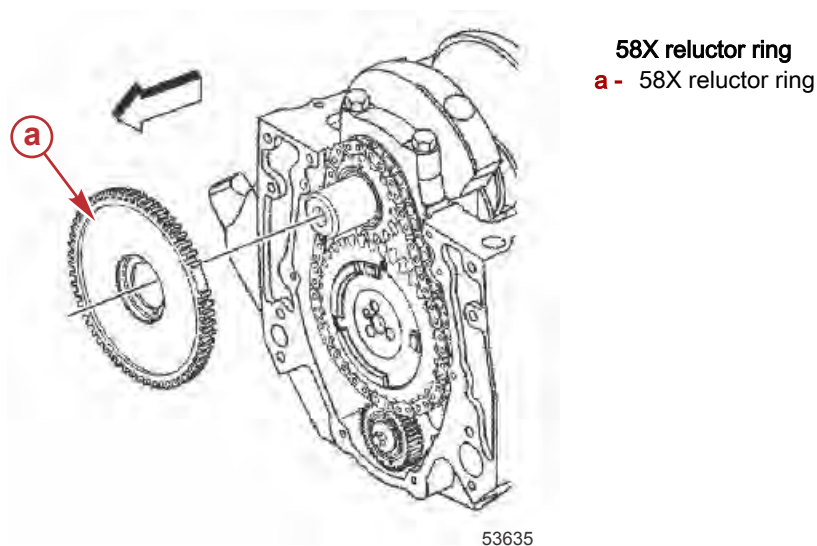
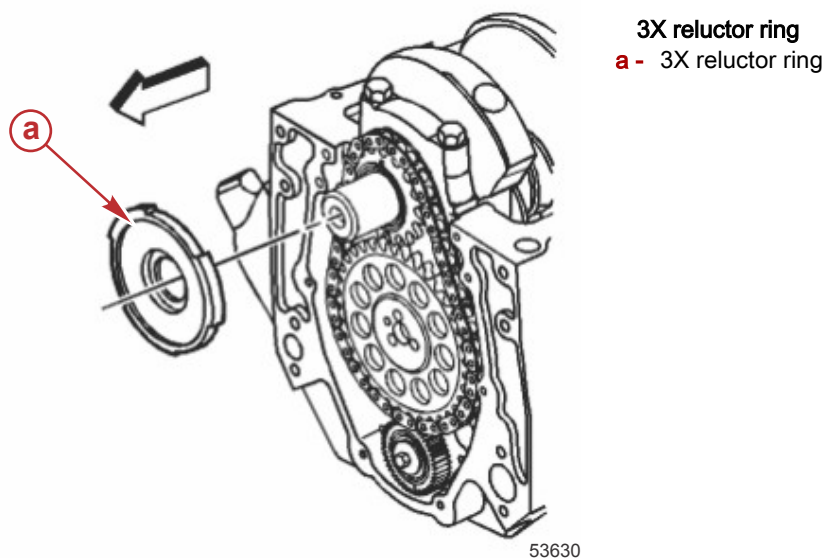
20. Install the timing chain.
21. Install the front cover.
22. Install the oil pump and crankshaft oil deflector.
23. Install the dipstick tube and oil pan.
24. Install the spark plugs.
25. Install the crankshaft balancer and crankshaft pulley.
26. Install the water circulating pump.
27. Install the belt.
28. Install the flywheel.
29. Install the flywheel housing.
30. Install the starter.
31. Install the new oil filter.
32. Fill the crankcase with oil. Refer to **Section 1C**.
33. Install the engine in the boat.

Timing Chain and Sprockets

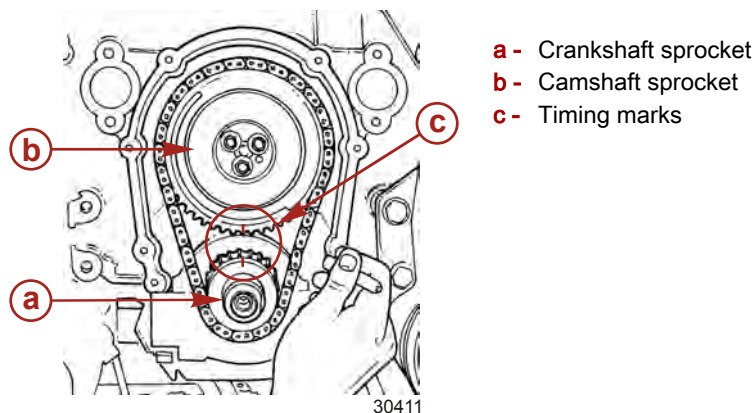
Removal

1. Remove the serpentine belt. Refer to **Section 1C**.
2. Remove the water circulating pump. Refer to **Section 6**.
3. Remove the crankshaft balancer. Refer to **Crankshaft Balancer**.
4. Remove the oil pan. Refer to **Oil Pan**.

5. Remove the front engine cover. Refer to **Crankcase Front Engine Cover**.



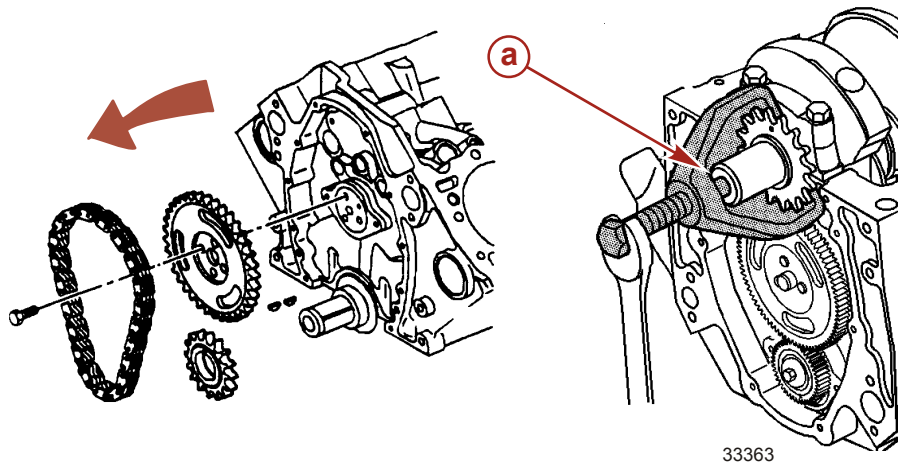
6. Remove the crankshaft position sensor reluctor ring.
7. Turn the crankshaft to align the timing marks on the crankshaft and camshaft timing sprockets or turn the crankshaft to cylinder number 4 TDC.



8. Check timing chain deflection. Refer to **Checking Timing Chain Deflection**.
9. Remove the camshaft sprocket.

NOTE: If the sprocket does not come off easily, a light tap on the lower edge of the sprocket with a plastic mallet should dislodge it.

10. Remove the timing chain.



a - Crankshaft sprocket remover

11. Remove the crankshaft sprocket using the crankshaft gear remover tool.

Description	Part Number
Kent-Moore crankshaft gear puller	J5825-A

Cleaning

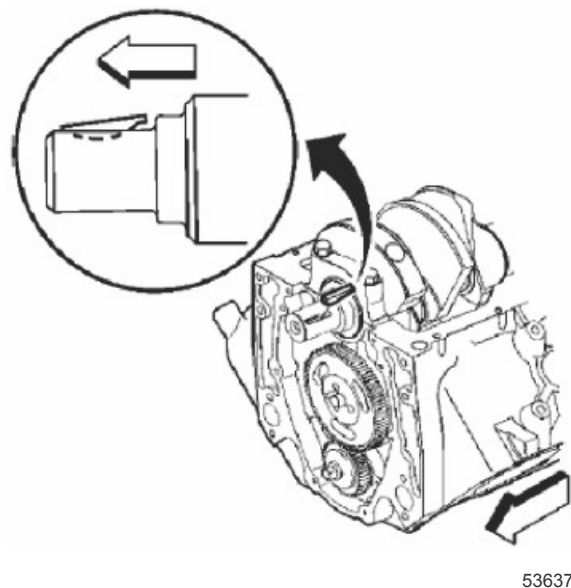
1. Clean all parts in solvent.
2. Dry the parts with compressed air.

Inspection

1. Inspect the timing chain for wear and damage.
2. Inspect the sprockets for wear and damage.
3. Replace the components as necessary.

Assembly

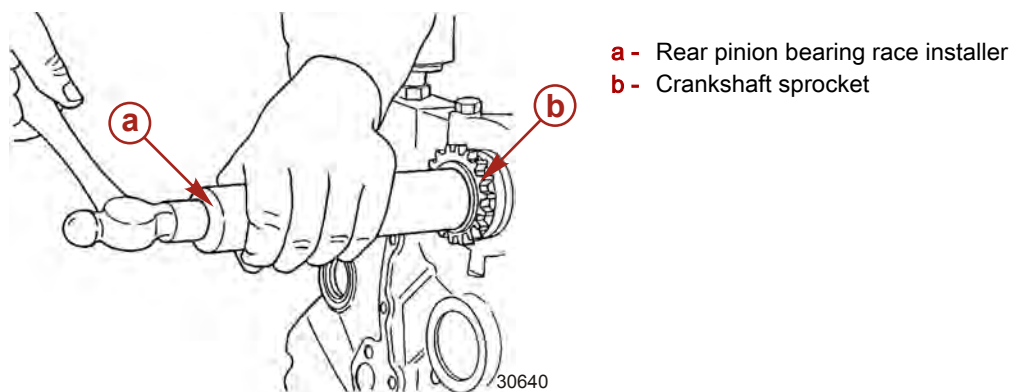
1. Install the crankshaft balancer key into the crankshaft keyway.



Crankshaft keyway

2. Align the keyway of the crankshaft sprocket with the crankshaft balancer key.
3. The crankshaft balancer key should be parallel to the crankshaft or with a slight incline.

4. Install the sprocket on the crankshaft by using the rear pinion bearing race installer tool.



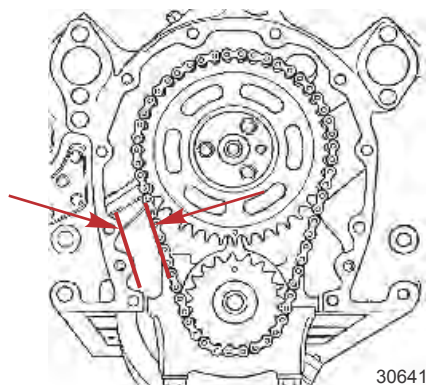
Description	Part Number
Rear pinion bearing race installer	J5590

5. Align the marks on the crankshaft and the camshaft sprockets.
6. Install the camshaft sprocket and timing chain. Tighten the sprocket screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Camshaft sprocket screws	25	–	18

Checking Timing Chain Deflection

1. Rotate the camshaft (in either direction) to place tension on one side of the chain.
2. Establish and mark a reference point on the block (on taut side of chain) and measure from this point to the chain.



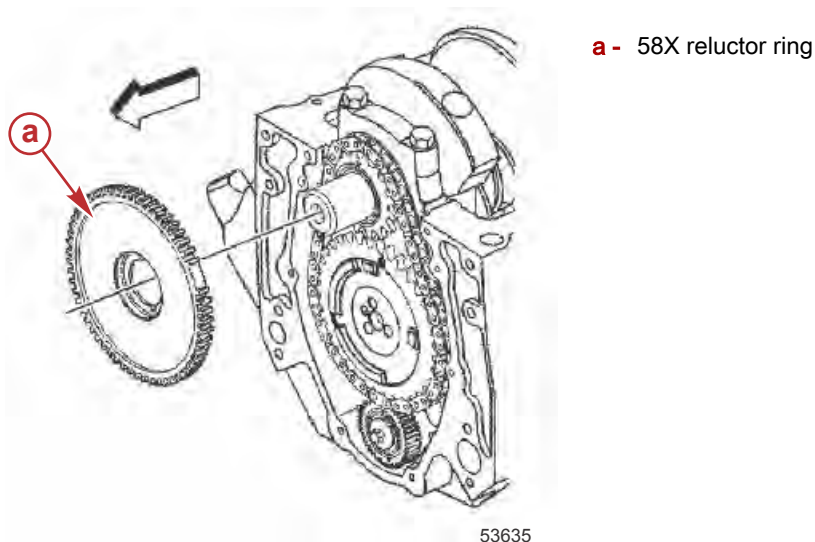
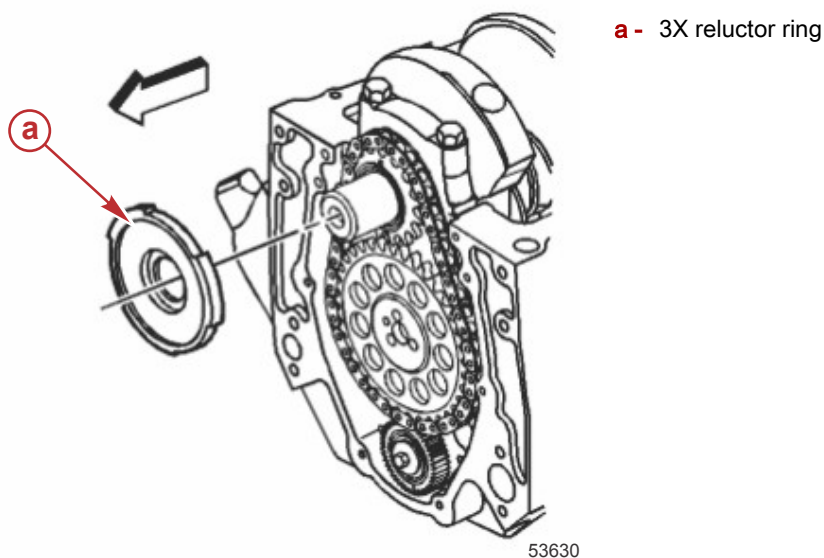
Measuring timing chain deflection

3. Rotate the camshaft in the opposite direction to provide slack in the chain.
4. Push chain in toward the sprockets and measure the distance between the reference point and timing chain.
5. The deflection is the difference between these two measurements. If the deflection exceeds specification, the timing chain should be replaced.

Description	4.3 Liter (262 cid)
Chain deflection	11 mm (0.4331 in.) maximum

Installation

1. Install the crankshaft position reluctor ring.



IMPORTANT: The front cover is not reusable per manufacturer's specification. It must be replaced if removed.

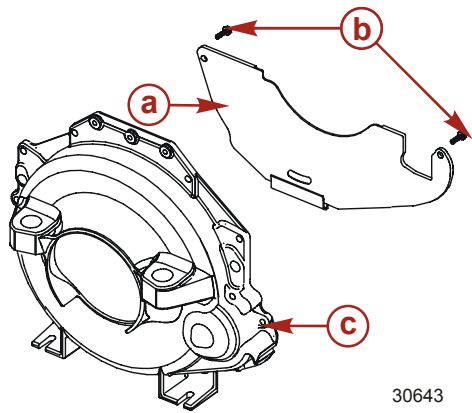
2. Install a new front cover and gasket. Refer to **Crankcase Front Engine Cover—Installation**.
3. Install the crankshaft balancer. Refer to **Crankshaft Balancer—Installation**.
4. Install the water circulating pump. Refer to **Crankcase Front Engine Cover—Installation**.

Flywheel Housing

Removal

1. Remove the sterndrive.
2. Remove the engine from boat.
3. Remove the water hoses from the power steering cooler (if equipped).
4. Remove the power steering cooler (if equipped).

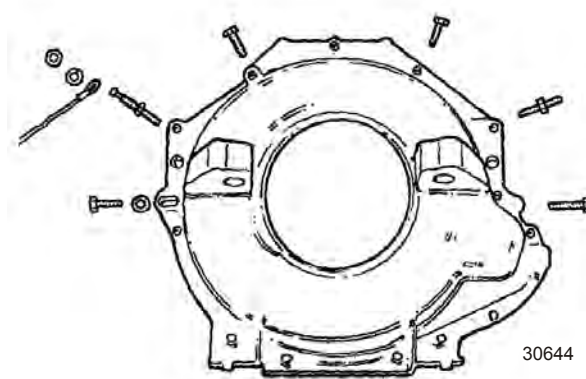
5. Remove the flywheel housing cover.



- a** - Flywheel housing cover
- b** - Screws (2)
- c** - Flywheel housing

30643

6. Remove the ground wires from the flywheel housing.
IMPORTANT: The flywheel housing bolts must be installed in the same location as removed.
7. Remove the screws and studs from the flywheel housing.
8. Remove the flywheel housing.



30644

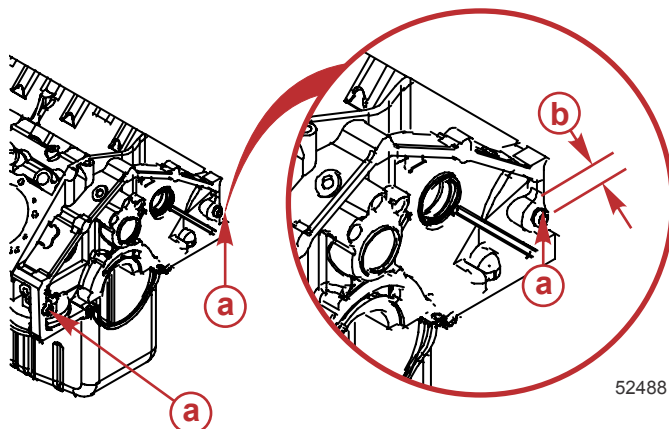
MCM shown

Cleaning

1. Clean all parts in solvent.
2. Dry the parts with compressed air.

Inspection

1. Inspect the flywheel housing for cracks, damaged bolt or stud holes, and excessive wear. Replace if necessary.
2. Inspect the guide dowels for the correct amount of protrusion from the engine block. Repair if necessary.



- a** - Guide dowels (2)
- b** - Measured protrusion 13 mm (0.5 in.)

52488

Installation

- Align the flywheel housing on the guide dowels of the engine.
IMPORTANT: The flywheel housing fasteners must be installed in the same location as removed.
- Install the studs and screws into their original locations.
- Tighten the flywheel housing fasteners to the specified torque.

Description	Nm	lb-in.	lb-ft
Flywheel housing fasteners	41	–	30

- Install the flywheel housing cover.

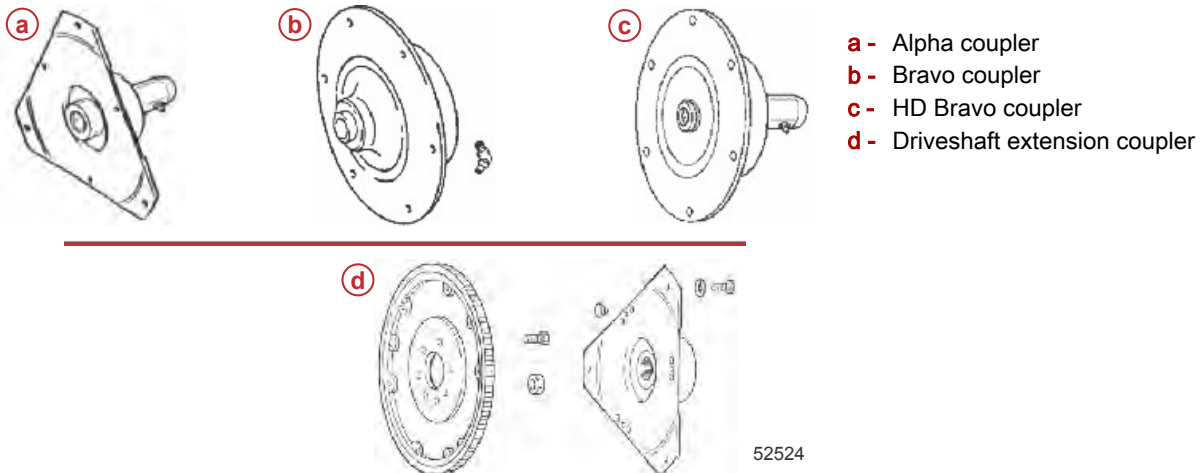
Description	Nm	lb-in.	lb-ft
Flywheel housing cover screws	9	80	–

- Install the ground wires.
- Install the power steering cooler (if equipped).
- Install the water hoses.
- Install the power package in the boat.

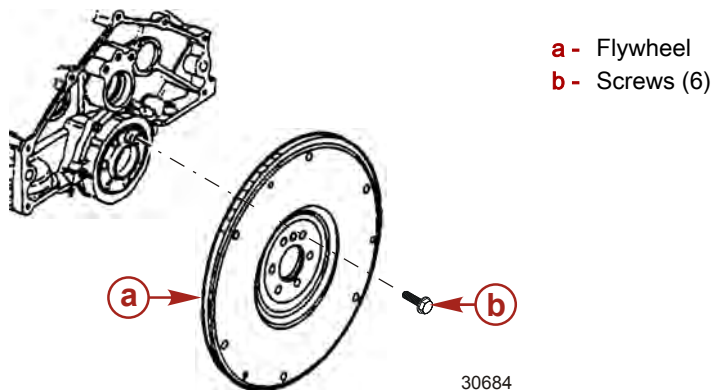
Flywheel

Removal

- Remove the flywheel housing.
- Remove the coupler or drive plate.



- Remove the flywheel.



Cleaning and Inspection

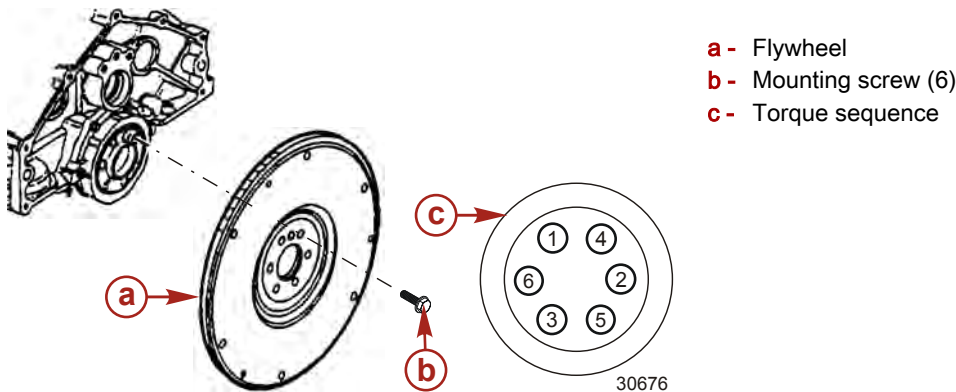
- Clean the mating surfaces of the flywheel and crankshaft. Remove any burrs. The mating surfaces must be clean, bare metal.

- 2. Inspect the flywheel ring gear for worn and missing teeth.
- 3. Inspect the splines in the drive plate or coupler for damage or excessive wear.
- 4. Replace components as necessary.

Installation

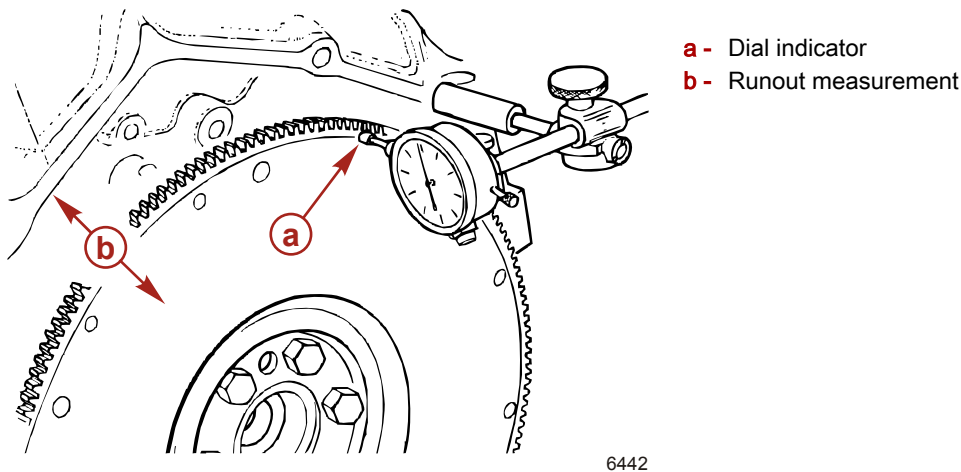
NOTE: If the crankshaft is to be replaced, but the old pilot bushing is to be reused, the bushing can be removed without damage by filling the pilot bushing cavity with grease, then inserting an old transmission input shaft into the bore of the bushing and hitting it with a hammer. This will create hydraulic pressure in the pilot bushing cavity forcing the bushing out.

- 1. Clean the mating surfaces of the flywheel and the crankshaft until the metal is bare.
- 2. Align the dowel hole in the flywheel with the dowel in the crankshaft and install the flywheel. Tighten the screws in sequence to the specified torque.



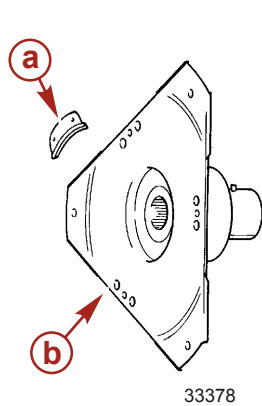
Description	Nm	lb-in.	lb-ft
Flywheel mounting screws	100	–	74

- 3. Check the flywheel runout:
 - a. Attach a dial indicator to the engine block.
 - b. Push in on the flywheel to remove any crankshaft end play.
 - c. Turn the flywheel in the direction of normal engine rotation and measure flywheel runout at the smooth outer edge of the flywheel just inside the ring gear.



Description	4.3 Liter (262 cid)
Runout	0.203 mm (0.0080 in.) maximum

4. Insert three rubber bumpers in the Alpha coupler before installation on the flywheel.



Typical

- a** - Rubber bumper (Alpha coupler only)
b - Coupler

5. Install the drive coupler or drive plate. Tighten the mounting screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Drive coupler or drive plate mounting screws	48	–	35

6. Install the flywheel housing and related parts.

Description	Nm	lb-in.	lb-ft
Flywheel housing mounting screws	48	–	35

7. Install the flywheel housing cover.

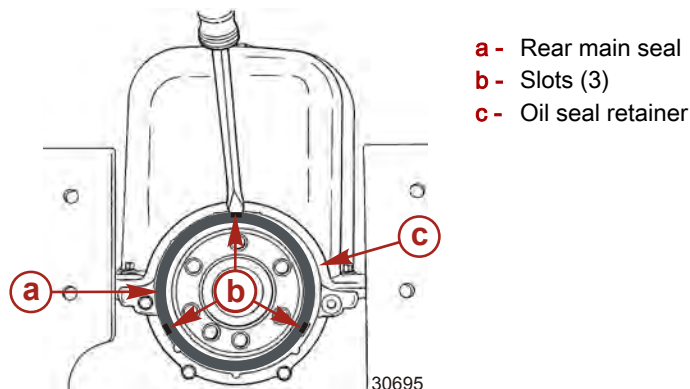
Description	Nm	lb-in.	lb-ft
Flywheel housing cover mounting screws	9	80	–

Rear Oil Seal

Removal

The rear main crankshaft oil seal can be replaced without removing the oil pan or the rear main bearing cap from the engine.

1. Remove the flywheel. Refer to **Flywheel**.
2. Remove the seal by using a screwdriver to pry it out of the engine block as shown.



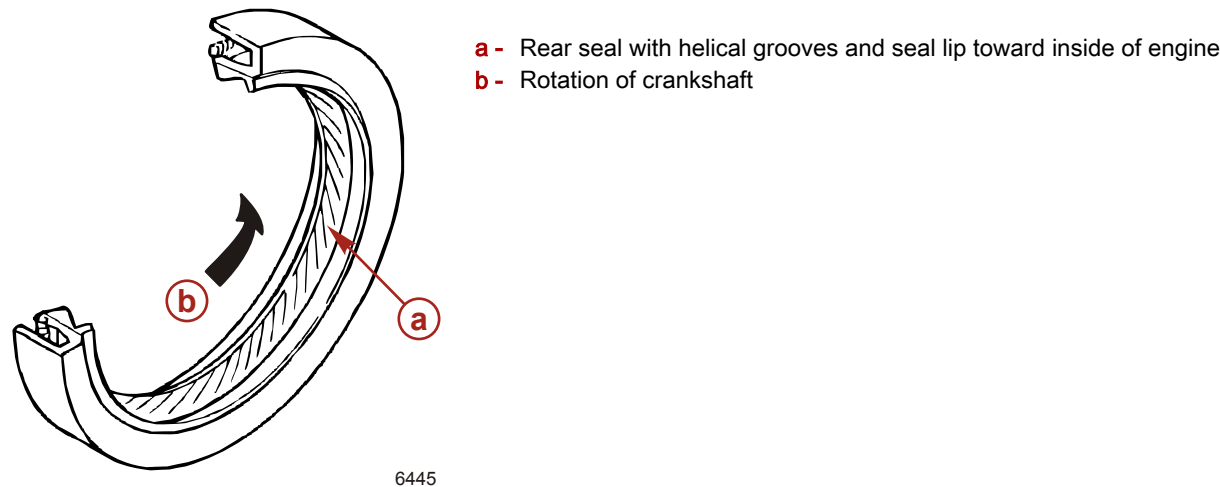
- a** - Rear main seal
b - Slots (3)
c - Oil seal retainer

IMPORTANT: Do not nick or gouge the engine block or the rear main bearing cap sealing surface. Protect the crankshaft to seal running surface from damage.

Cleaning and Inspection

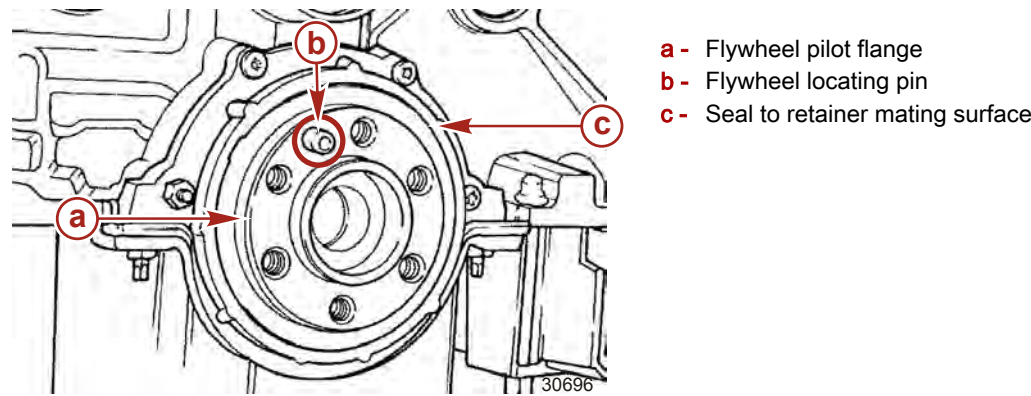
1. Clean the crankshaft to seal running surface and the seal retainer.
2. Inspect the seal retainer for damage.
3. Inspect the seal lip for tears and deformity.

IMPORTANT: The oil seal must be orientated correctly to prevent oil leaks.



Installation

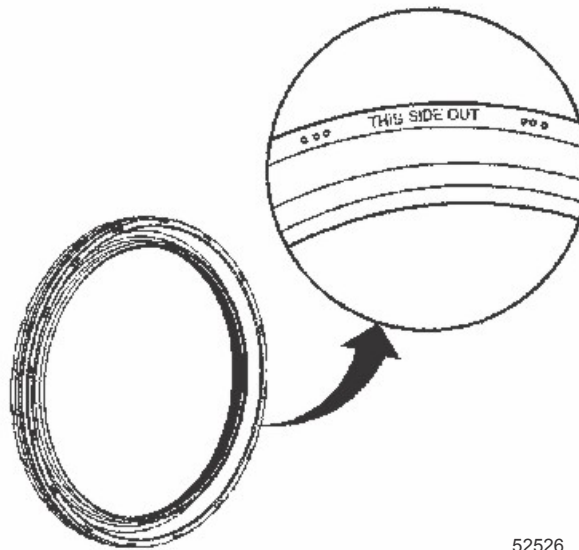
- 1. Remove the installation guide from the new crankshaft rear oil seal.
- 2. Apply engine oil to the seal to retainer mating surfaces, the seal lip, the flywheel pilot flange, and the flywheel locating pin.



Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	The seal to retainer mating surfaces, the seal lip, the flywheel pilot flange, and the flywheel locating pin	Obtain Locally

- 3. Orient the seal so that the seal lip is facing toward the inside of the engine and place squarely into the rear main seal installer.

IMPORTANT: The oil seal must be orientated correctly to prevent oil leaks.

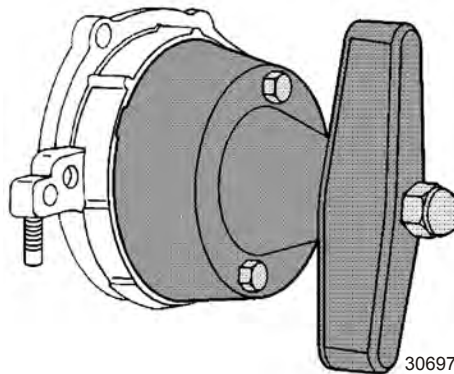


52526

IMPORTANT: Note the direction of the rear oil seal. The new design seal is a reverse style as opposed to what has been used. "THIS SIDE OUT" has been stamped into the seal as shown in the graphic.

Description	Part Number
Kent-Moore rear main seal installer	J35621-B

4. Install the seal using the rear main seal installer.
 - a. Attach the rear main seal installer to the crankshaft and evenly tighten the attaching screws until the installer is squarely flush against the engine.



30697

Seal installer

- b. Turn the installer wing-nut clockwise until the seal is evenly seated in the seal retainer.
 - c. Turn the installer wing-nut counterclockwise to release the installer from the oil seal.
5. Remove the installer.
6. Wipe off any excess oil.

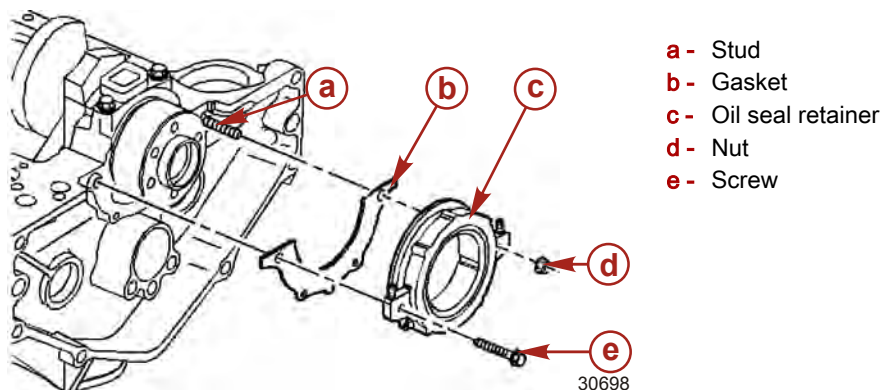
Rear Oil Seal Retainer

Removal

The rear oil seal retainer can only be replaced with the oil pan removed.

1. Remove the oil pan. Refer to **Oil Pan**.

- Remove the oil seal retainer fasteners.



- Remove the oil seal retainer.
- Remove and discard the old oil seal retainer gasket.

Cleaning

- Remove all gasket material from the seal retainer, oil pan, and engine block.
- Clean all sealing surfaces.
- Wash all removed parts in solvent and dry with compressed air.

Inspection

- Inspect the oil seal retainer for cracks or any scored surface.
- Inspect the oil seal for worn, dry, or torn rubber. Replace if necessary.
- Inspect the flywheel locator pin for damage. Replace if necessary.

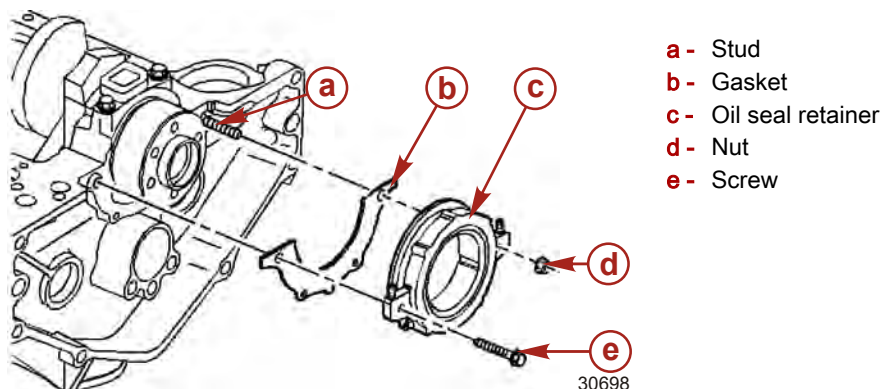
Installation

IMPORTANT: Always use a new oil seal retainer gasket.

- Install the rear oil seal retainer stud, if removed previously. Tighten the stud to the specified torque.

Description	Nm	lb-in.	lb-ft
Rear oil seal retainer stud	6	53	–

- Install a new rear oil seal retainer gasket.
- Install the rear oil seal retainer onto the stud.



- Install the retainer nut and screw and tighten to the specified torque.

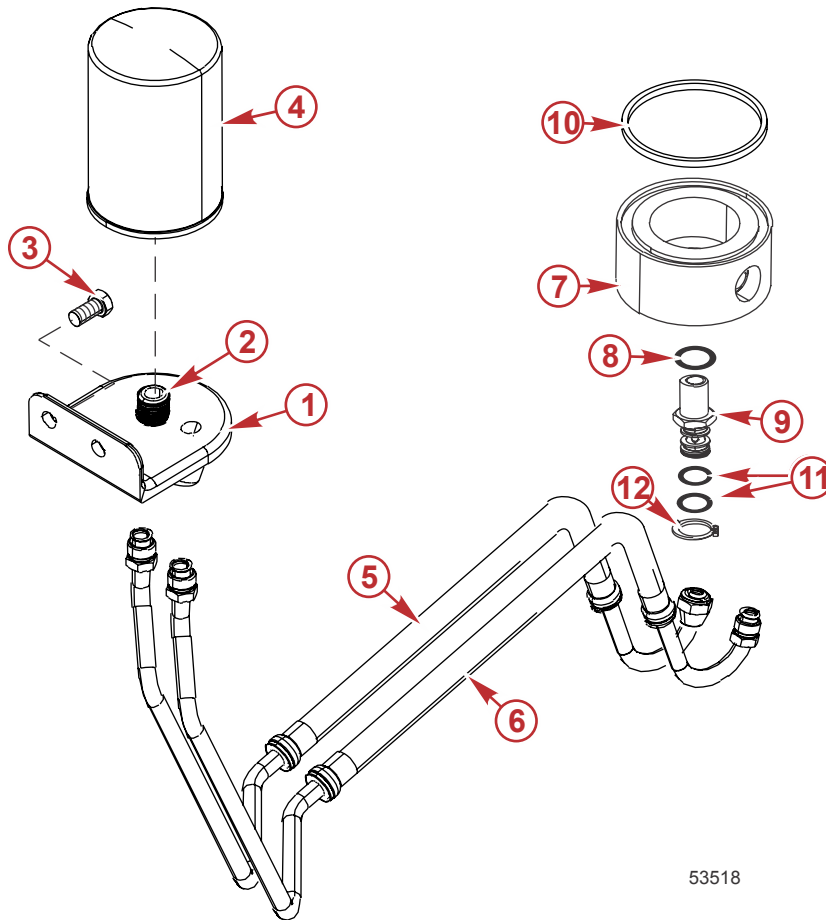
Description	Nm	lb-in.	lb-ft
Rear oil seal retainer fasteners	12	106	–

- If not already installed, install the rear oil seal.
- Install the oil pan. Refer to **Oil Pan**.

Oil Filter By-Pass Valve and Block Adapter

IMPORTANT: The oil filter by-pass valve and block adapter assembly should be inspected whenever the engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

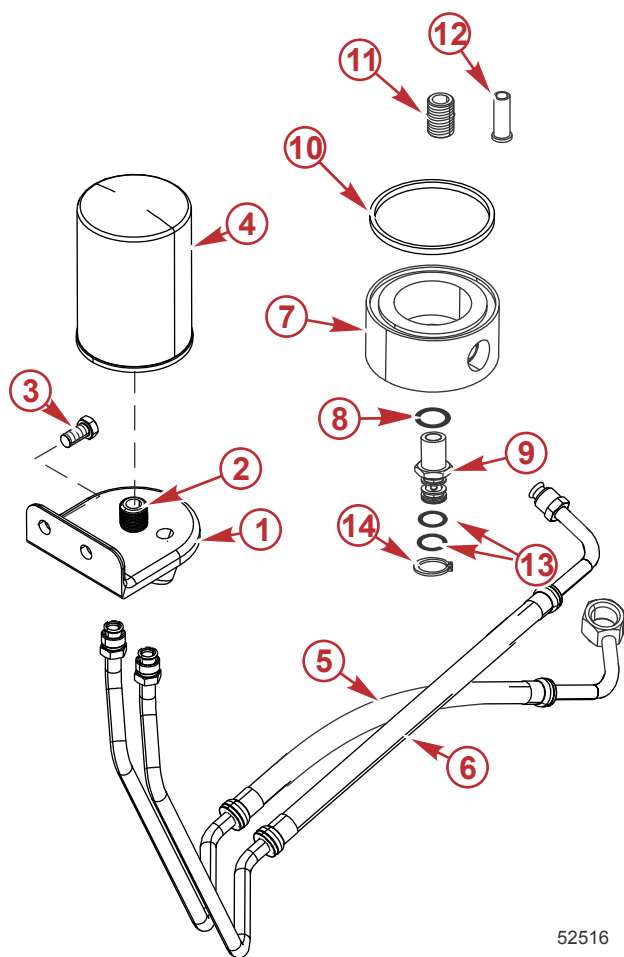
Exploded View



TKS

- 1 - Oil filter bracket
- 2 - Fitting
- 3 - Screw (0.375-16 x 0.750)
- 4 - Oil filter
- 5 - Oil hose
- 6 - Oil hose
- 7 - Adapter
- 8 - Seal
- 9 - Fitting
- 10 - Gasket
- 11 - O-ring
- 12 - Clip

53518



MPI

- 1 - Oil filter bracket
- 2 - Fitting
- 3 - Screw (0.375-16 x 0.750)
- 4 - Oil filter
- 5 - Oil hose (to adapter)
- 6 - Oil hose (from adapter)
- 7 - Oil filter adapter
- 8 - Seal
- 9 - Fitting
- 10 - Gasket
- 11 - Adapter
- 12 - Bypass valve
- 13 - O-ring
- 14 - Clip

52516

Removal

1. Remove the oil line from the block adapter housing.
2. Remove the snap ring and O-rings.
3. Remove the nut fitting and swivel tube seal. Discard the swivel tube seal.
4. Remove the block adapter housing and seal. Discard the seal.

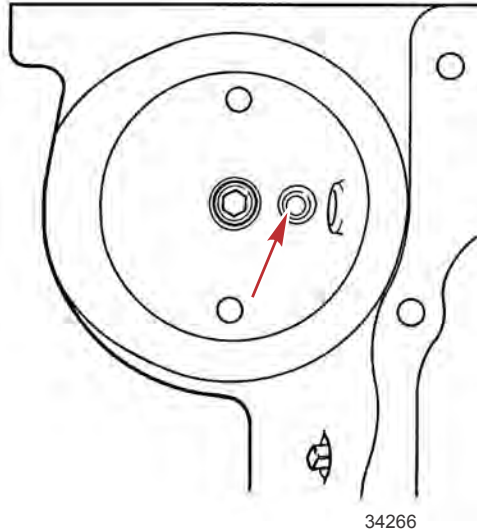
Cleaning

1. Put on safety glasses.
2. Clean the bypass valve and block adapter assembly in solvent.
3. Dry with compressed air.
4. Clean the fitting and oil filter adapter in solvent.
5. Dry with compressed air.

Inspection

1. Inspect the adapter for cracks, thread wear, or other damage.
2. Inspect the bypass valve for cracks or other damage.

- Ensure that the bypass valve fits tightly against its seat. Push the valve down and release it. Valve should return freely to its seat. If valve operation is questionable, the bypass valve should be replaced.



Typical bypass valve

Installation

- Install the block adapter and gasket, turn the fitting clockwise into the threaded fitting of the engine block. Position the threaded hole of the block adapter housing toward the outside of the engine. Tighten the fitting to the specified torque.

Description	Nm	lb-in.	lb-ft
Fitting	31	–	23

- Connect the remote oil return line to the threaded port of the block adapter assembly. Tighten the fitting to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil return line fitting	27	–	20

- Connect remote oil delivery line to the fitting of the block adapter assembly.
- Lightly lubricate the O-rings on the fitting.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Block adapter O-rings	Obtain Locally

- Align the remote oil delivery line fitting to the fitting and apply upward pressure to oil line fitting until both O-rings are seated.
- Ensure that the remote oil delivery line fitting is flush with the block adapter housing and that the O-rings are not visible.
- Install the snap ring in the bottom groove of the fitting.

Notes:

Engine

Section 3B - V6 Longblocks

Table of Contents

3X and 58X Longblock Differences.....	3B-2	Additional Parts Required to Replace a 3X Longblock with a 58X Longblock.....	3B-2
Longblock Replacement Parts.....	3B-2		

**3
B**

3X and 58X Longblock Differences

Longblock Replacement Parts

MerCruiser uses General Motors 4.3 L V6 longblocks in production. Beginning with serial number 1A063240, General Motors changed from a 3X (segment) reluctor wheel to a 58X (segment) reluctor wheel on 4.3 L V6 engines, allowing for more precise ignition timing and fuel management. 3X reluctor wheel longblocks are no longer available. The 58X longblock configuration is also used on carbureted engines that do not use a crankshaft position sensor for timing.

IMPORTANT: When replacing a longblock for a V6 engine with a serial number below 0M324698 or with one-piece exhaust manifolds, you must order the correct Mercury-remanufactured longblock. See the Mercury Remanufacturing Product Guide for part numbers. A seawater pump bracket is not available for 4.3 L carbureted engines with Bravo sterndrives and seawater cooling. This single application requires a remanufactured longblock.

IMPORTANT: The 58X longblock does not use a knock sensor. Do not attempt to use the knock sensor from a 3X longblock with a 58X replacement longblock.

NOTE: Refer to the following tables for additional parts required to use a 58X replacement longblock on engines with two-piece exhaust manifolds, serial number 0M324698 and later.

Additional Parts Required to Replace a 3X Longblock with a 58X Longblock

NOTE: Remanufactured longblocks require gasket sets (refer to **Table 1**). Refer to the following tables for additional required parts when ordering a new replacement longblock.

Table 1: Longblocks

Order the following parts, as specified. Refer to Table 2 for required wiring and gaskets.

Engine Model	Serial Number Range	Mercury Remanufactured Longblock Part Numbers (order gaskets separately)	New Longblock Part Numbers (intake and exhaust gaskets included)
4.3 L carbureted	0M324698 and above	Refer to the Mercury Remanufacturing Guide	879150A31
4.3 L MPI	0M324698–0W649999	864256R05	879150A31
4.3 L MPI	0W650000–1A063239	864256R05	879150A31
4.3 L MPI	1A063240 and above	N/A	879150A31

Table 2: Wiring and Gaskets

Order the following parts, as specified.

Engine Model	Serial Number Range	Required Parts
4.3 L carbureted	0M324698 and above	None
4.3 L MPI	0M324698–0W649999	14-pin to 10-pin adapter harness 84-866337T01 Engine harness with brackets 84-879150T47 Transom harness 84-865677T02 IAC adapter 866295A02 Screw 10-40086-12, qty. 2 Screw 10-40088-20, qty. 2 ECM as specified in Table 3
4.3 L MPI	0W650000–1A063239	Engine harness without brackets 84-879172155 ECM as specified in Table 3
4.3 L MPI	1A063240 and above	None

Table 3: New ECM Required to use the New 58X 4.3 L V6 Longblock

Order the proper ECM when replacing engine serial numbers 0M324698–1A063239. Match the drive type and cooling system to determine the proper calibration.

Drive	Engine Cooling System	Part Number
Alpha	Seawater cooled	865830T08
Alpha	Closed cooling	865831T08
Bravo	Seawater cooled	865832T07
Bravo	Closed cooling	865833T07

Table 4: Seawater Pump Bracket

Order a new seawater pump mounting bracket for all Bravo-equipped models below serial number 1A063240.

Engine Model	Serial Number Range	Seawater Pump Bracket
Carbureted models with Bravo drive and seawater cooling	0M324698–1A063239	No bracket available. Use a 3X remanufactured longblock engine only.
MPI models with Bravo drive and seawater cooling	0M324698–1A063239	865143T01
Carbureted models with Alpha or Bravo drive and closed cooling	0M324698–1A063239	865143T01
MPI models with Alpha or Bravo drive and closed cooling	0M324698–1A063239	865143T01

Notes:

Electrical System

Section 4A - Starting System

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**4
A**

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 25 	Liquid Neoprene	Electrical connections	92- 25711 3

Special Tools

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Starter Specifications

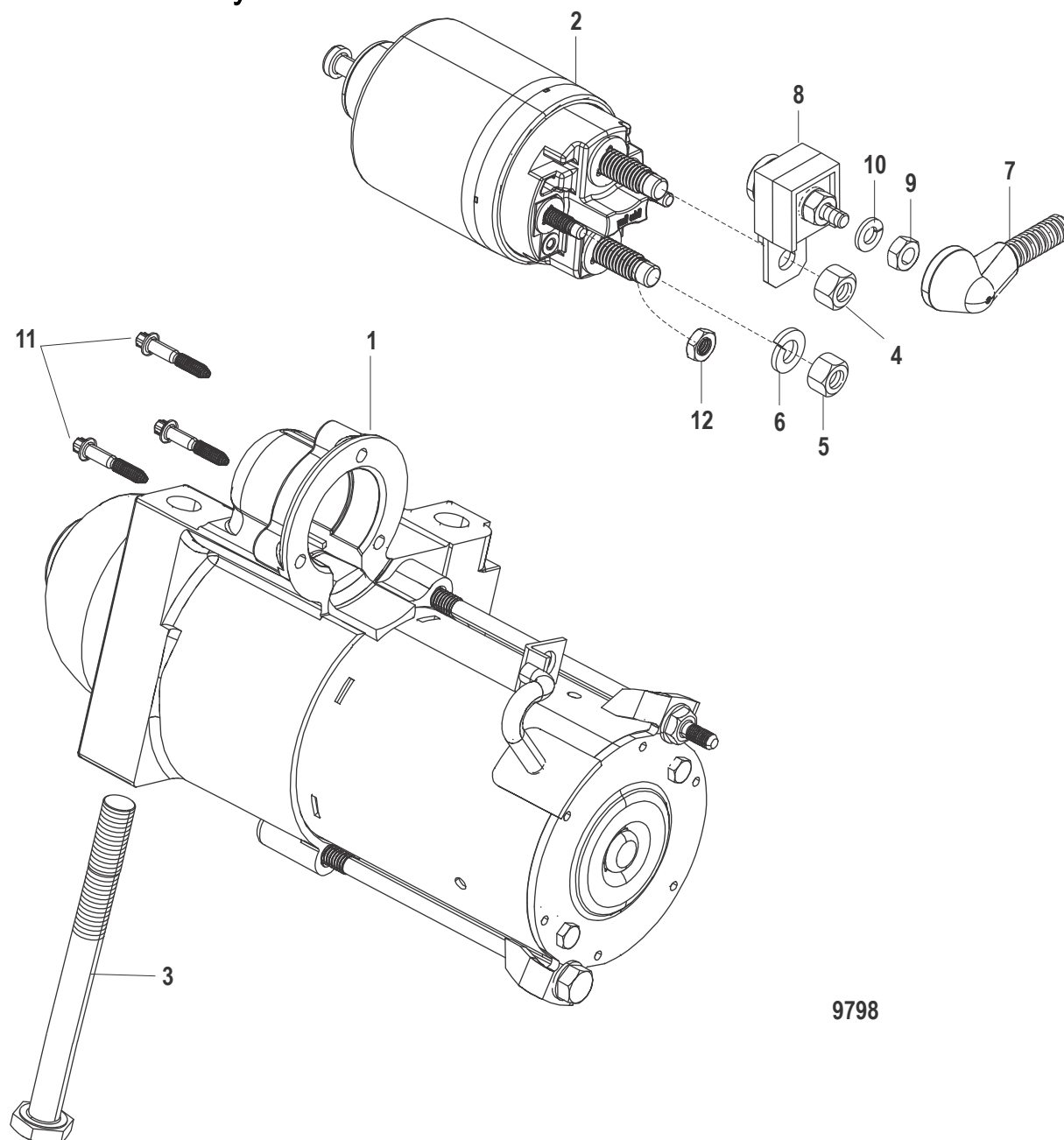
The permanent-magnet gear-reduction starter motor features small permanent magnets mounted inside its field frame. These magnets take the place of current-carrying field coils mounted on iron pole pieces. A 4:1 ratio internal gear reduction results in armature speeds in the 7000 RPM range. The armature and driveshaft are mounted on roller or ball bearings in the place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

Delco Starter Specifications

Model	Delco ID Number	Engine Rotation	Volts	No Load Test			
				Minimum Amp Draw	Maximum Amp Draw	Minimum RPM	Maximum RPM
PG260G1	9000884	LH	12.0	35	85	2550	4150

Exploded Views

Starter Motor Assembly



9798

Starter Motor Assembly

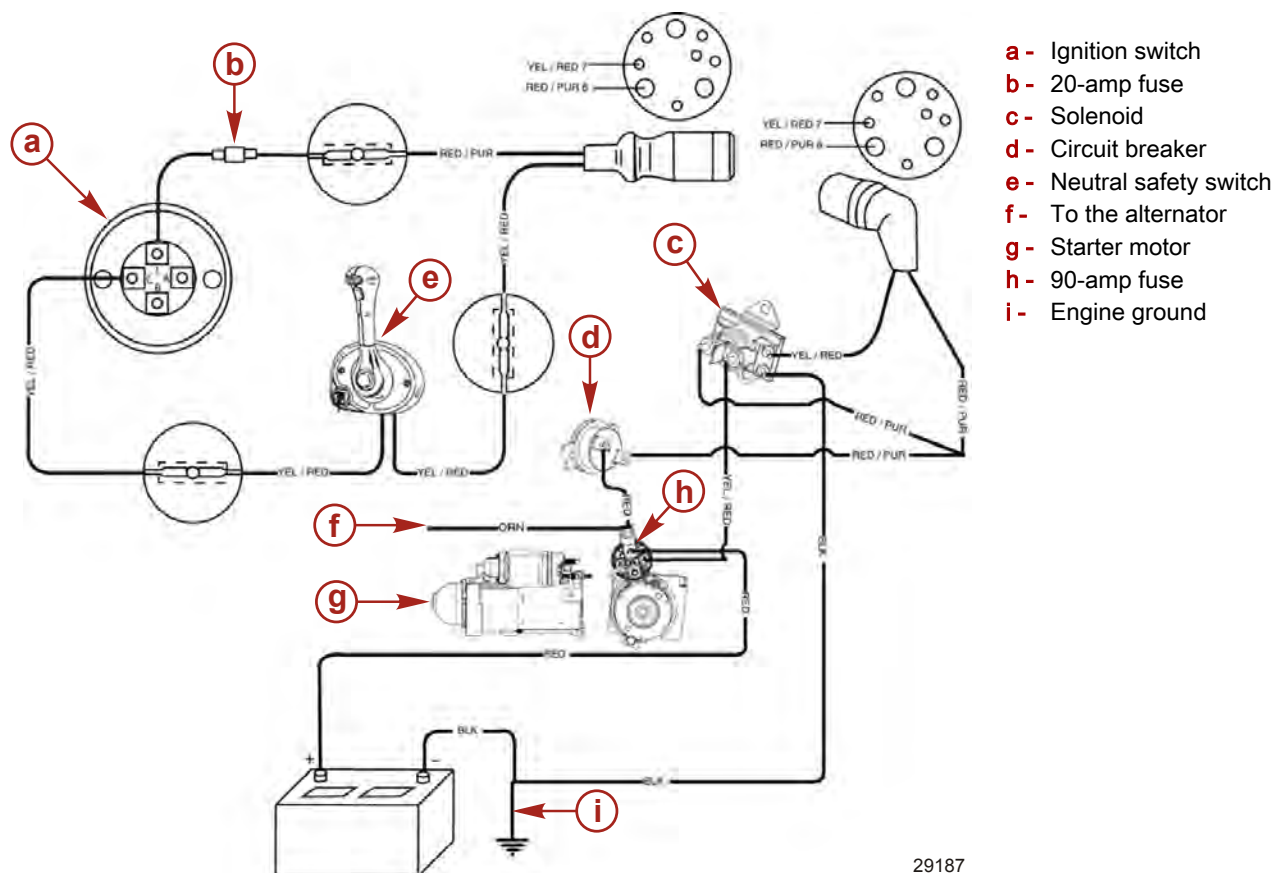
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Starter motor assembly			
2	1	Solenoid			
3	2	Bolt (M10 x 1.5)	47.5	–	35
4	1	Nut (M8-1.5)			
5	1	Nut (M8-1.5)	9.5	84	–
6	1	Lockwasher			
7	1	Insulator boot			
8	1	90-amp fuse assembly			
9	1	Nut (250-28)			
10	1	Lockwasher (M8)			
11	3	Screws	4.0–4.5	35–40	–
12	2	Nut (M5)	2	18	–

Diagrams

Wire Color Code Abbreviations

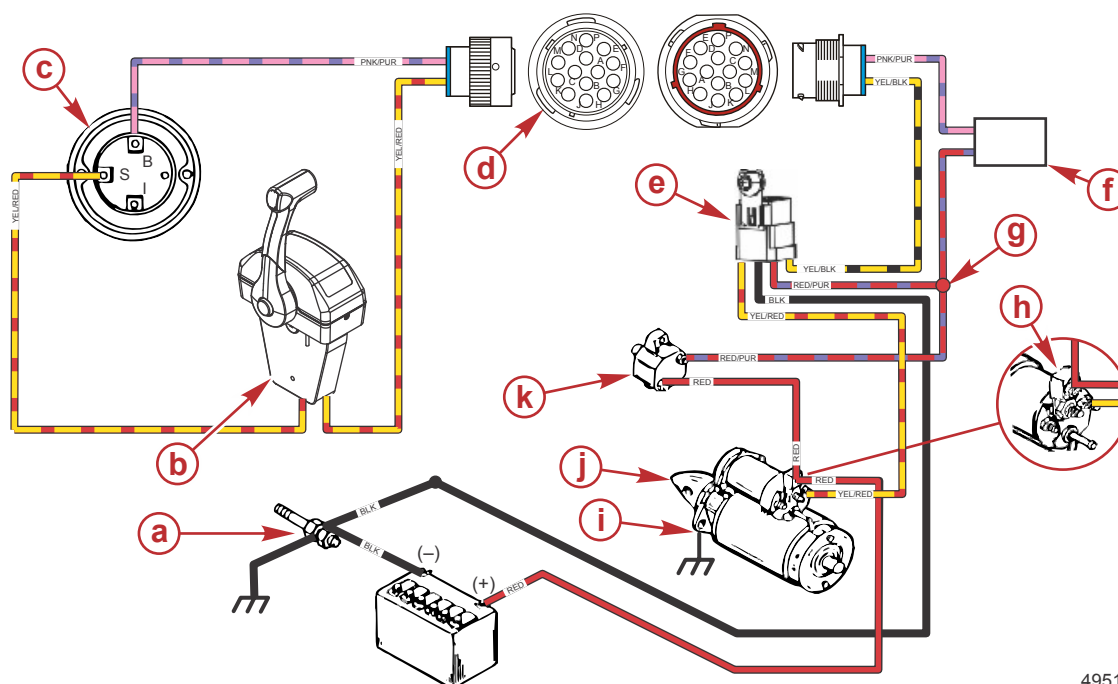
Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

10-Pin Starting Circuit



29187

14-Pin Starting Circuit



- a** - Engine ground (-)
- b** - Neutral safety switch
- c** - Ignition switch
- d** - 14-pin connector
- e** - Starter relay
- f** - Fuse block
- g** - Wire junction
- h** - 90-amp fuse
- i** - Engine ground (-), via starter mounting bolt
- j** - Starter motor
- k** - Circuit breaker

Starting Circuit Control Current Flow

Refer to the previous diagram. Following ignition switch activation, control current flows:

- From the battery positive (+) post to the starter-mounted solenoid (red battery cable)
- From the solenoid switch to the circuit breaker (red)
- From the circuit breaker to the wire junction (red/purple)
- From the wire junction to the fuse block (red/purple)
- From the fuse block to the 14-pin connector terminal A (pink/purple)
- From the 14-pin connector terminal A to the ignition switch terminal B (pink/purple)
- From the ignition switch terminal B to terminal S

NOTE: Current flows across the switch (terminal B to terminal S) only when it is in the "START" position.

- From the ignition switch terminal S to the neutral start switch (yellow/red)
- From the neutral safety switch to the 14-pin connector terminal N (yellow/red)

NOTE: The neutral safety switch must be in the neutral position before current can flow from the switch to the wiring harness.

- From the 14-pin connector terminal N to the starter relay terminal 86 (yellow/black)
- From the starter relay terminal 86 across the relay's coil to terminal 85

NOTE: When the starter relay's coil is energized, the contacts between terminals 30 and 87 are closed, allowing current to flow to the starter solenoid. Refer to **Starter Solenoid Current Flow** for details.

- From the starter relay terminal 85 to the engine ground (black)

- From the engine ground to the negative (–) battery post (black battery cable)

Starter Solenoid Current Flow

Once the starter relay is engaged, the current needed to engage the solenoid mounted on the starter motor flows:

- From the positive (+) post of the battery to the starter mounted solenoid (red battery cable)
- From the solenoid to the circuit breaker (red)
- From the circuit breaker to the wire junction (red/purple)
- From the wire junction to the starter relay terminal 30 (red/purple)
- Across the closed relay contact to terminal 87
- From the terminal 87 to the "S" stud on the starter-mounted solenoid (yellow/red)
- From the solenoid "S" stud across the starter solenoid coil

NOTE: When the starter solenoid coil is energized, it closes contacts that allow current to flow to the starter motor. Refer to **Starter Motor High Current Flow** for details.

- From the solenoid coil, through the starter mounting bolts to the engine ground
- From the engine ground to the negative (–) post of the battery (black battery cable)

Starter Motor High Current Flow

Once the starter mounted solenoid is engaged, the high current needed to run the starter motor flows:

- From the positive (+) post of the battery to the post on the starter mounted solenoid (red battery cable)
- From the post on the solenoid to the 90-amp fuse
- Through the 90-amp fuse to the starter motor solenoid's closed contacts
- Across the closed contacts to the starter motor windings

NOTE: With the starter motor's windings energized, its attached gears engage with the flywheel, cranking the engine.

- From the starter motor windings to the starter casing; then, through the starter motor mounting bolts to engine ground
- From the engine ground to the negative (–) post of the battery (black battery cable)

Relay Bench Test

Removing the Relays

IMPORTANT: Do not pull the harness to remove the relays. Ensure that the mounting tab is properly seated in the grommet when remounting the relays.

Access to the relays is provided by unbolting the PCM from the electrical panel and pulling it away while leaving the connections intact.

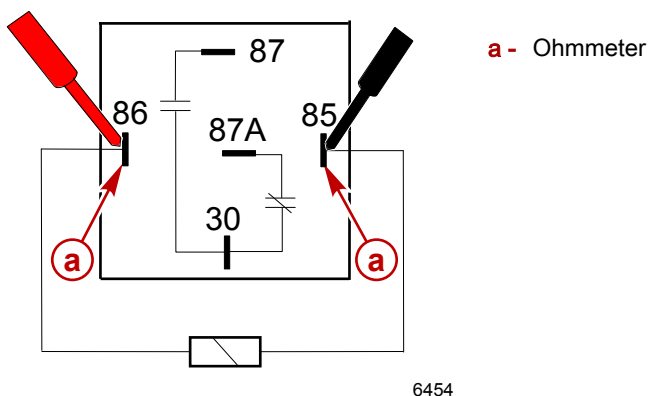
Bench Testing Relays

The following table identifies the relay and each pin's corresponding socket wire colors.

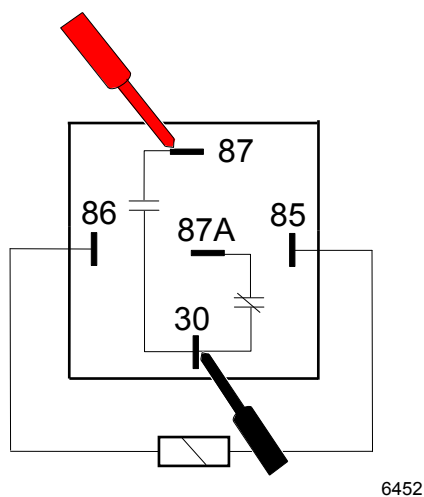
Description	Terminal 85 (Coil)	Terminal 86 (Coil)	Terminal 30 (Contact)	Terminal 87 (Contact)
Main Power 1 and 2	RED/BLU	YEL/PPL	RED	RED/GRN
Master Fuel Pump	RED/BLU	YEL/BLK	RED	RED/BLK
Fuel Pump 1 and 2	BLK	RED	RED	RED

1. Measure the coil resistance. If it is not within specification, discard the relay.

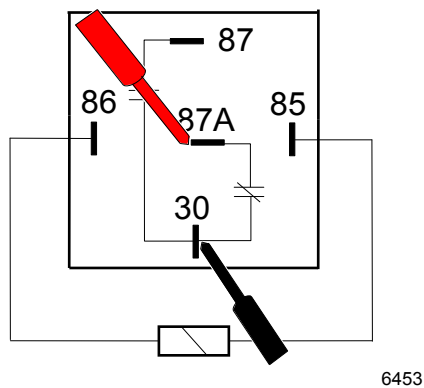
Description	Resistance
Relay coil resistance	75–95 ohms



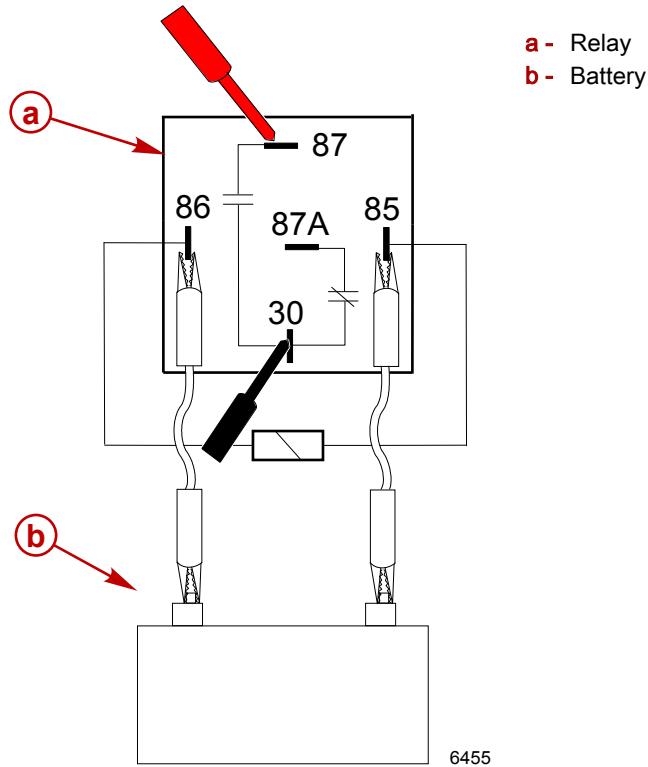
2. Check continuity between pins 87 and 30. The contacts should be open (infinite resistance). If not, discard the relay.



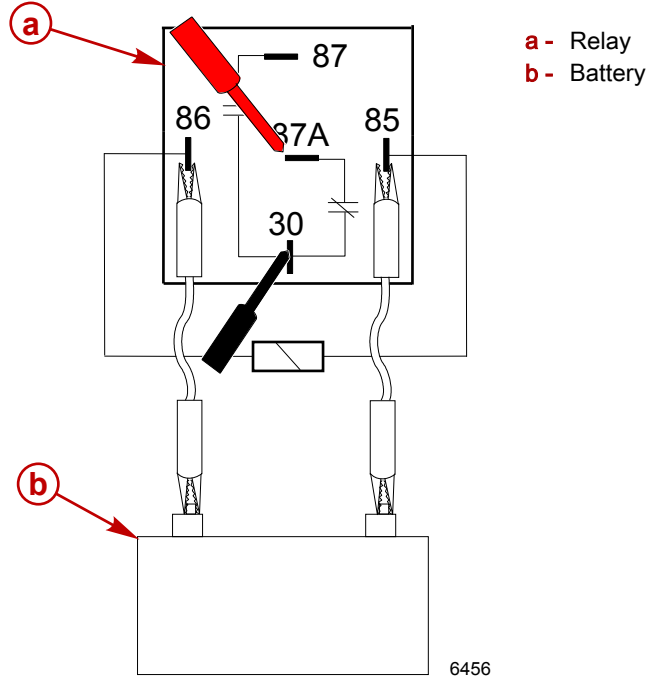
3. Check continuity between pins 87A and 30. The contacts should be closed (little or no resistance). If not, discard the relay.



- Energize the coil with an external 12 volt DC power source and check continuity between pins 87 and 30. The contacts should be closed (little or no resistance). If not, discard the relay.



- Energize the coil with an external 12 volt DC power source and check continuity between pins 87A and 30. The contacts should be open (infinite resistance). If not, discard the relay.



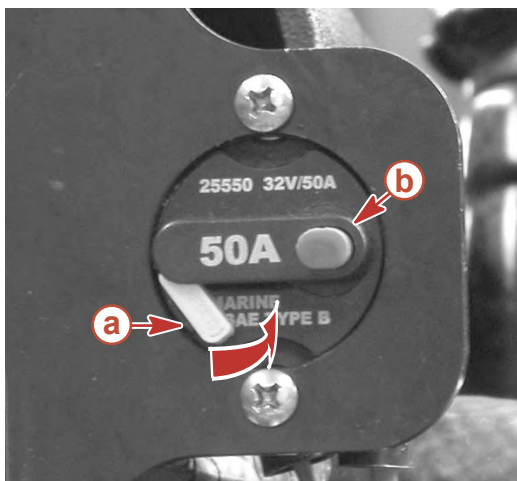
Electrical System Overload Protection

If an electrical overload occurs, a fuse will blow or the circuit breaker will trip open. The cause must be found and corrected before replacing the fuse or resetting the circuit breaker.

NOTE: In an emergency, when you must operate the engine and cannot locate the cause for the high current draw, turn off or disconnect all accessories connected to the engine and instrumentation wiring. Reset the circuit breaker. If the breaker reopens, the electrical overload has not been eliminated. Troubleshoot accordingly.

The circuit breaker located near the 14-pin harness connector (beneath the engine cover) provides overload protection for the engine wiring harness and the instrumentation power lead.

1. If the circuit breaker is of the lever style, the circuit breaker can be tested or reset as follows.
 - a. Push the red test button on the circuit breaker. A yellow lever appears if the circuit breaker is functioning properly.
 - b. Reset the breaker by rotating the yellow lever back into the housing.



22529

Yellow lever style circuit breaker

- a** - Yellow lever
b - Red test button

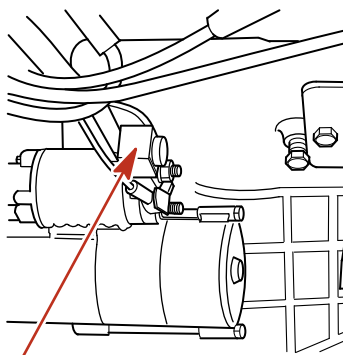
2. If the circuit breaker is of the pushbutton style, the circuit breaker can be reset by pushing in on the red button.



51185

Pushbutton style circuit breaker

3. A 90-amp fuse, located on the large post of the starter solenoid, protects the engine wiring harness from an electrical overload.



mc74907-1

Battery Cables for MerCruiser Models

IMPORTANT: The OEM or designer of the vessel is responsible for selecting the proper battery cable size to replace the minimum size listed in the Circuit Length and Cable Size table, if the cables are used for electrical loads in addition to cranking the engine.

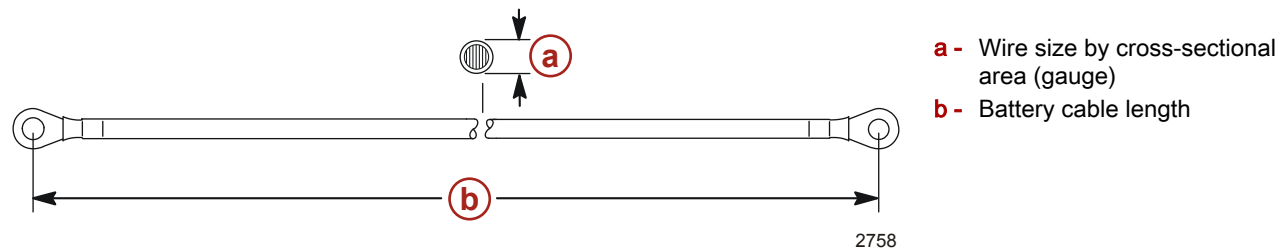
IMPORTANT: Use only copper battery cables. Do not use aluminum cables for marine installations.

Starting System

IMPORTANT: Terminals must be soldered to the cable ends to ensure good electrical contact. Use only electrical-grade (rosin flux) solder. Do not use acid flux solder, as it may cause corrosion and a subsequent failure.

NOTE: Engine starting batteries should be located as close to the engine as possible.

See the following figure for correctly sizing cables. If longer battery cables are required, the cable size (gauge) must increase.



Circuit length is calculated by adding the total length of the positive (+) cranking circuit to that of the negative (-) cranking circuit (positive battery post to negative battery post).

Use the same cable size for both positive and negative cables.

Circuit Length and Cable Size

Circuit Length	Minimum Cable Size (see notes)
Less than or equal to 2.7 m (9 ft)	13.3 mm ² (6 AWG)
2.7–4.6 m (9–15 ft)	21.2 mm ² (4 AWG)
4.6–7.6 m (15–25 ft)	33.6 mm ² (2 AWG)
7.6–9.5 m (25–31 ft)	42.4 mm ² (1 AWG)
9.5–11.9 m (31–39 ft)	53.5 mm ² (0 AWG)
11.9–15.2 m (39–50 ft)	67.7 mm ² (00 AWG)
15.2–19.2 m (50–63 ft)	85.2 mm ² (000 AWG)
19.2–24.4 m (63–80 ft)	107 mm ² (0000 AWG)

NOTE: Consider the following information before choosing your cables:

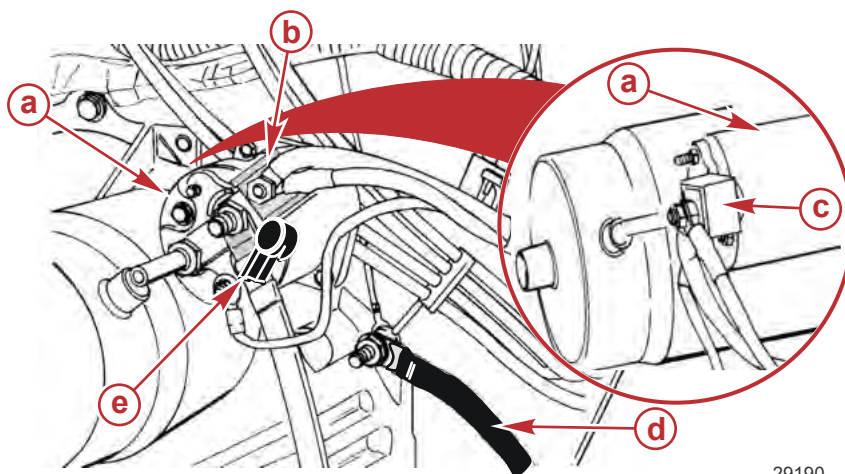
- Two numbers are provided for minimum cable size. The second number (in parentheses) is the American Wire Gauge (AWG) cable recommended by MerCruiser for the indicated cranking circuit length. The first number is an approximate cross-sectional area equivalent to the AWG number, expressed in square millimeters (mm²). This equivalent is to be used as the minimum cable size when selecting cables not denoted in gauge, such as ISO sizes. Always round up.
- All listed cables are sized for **engine cranking only**.

Starter

Inspection

The starter motor and the solenoid are completely enclosed in the drive housing to prevent contamination by moisture and dirt. Periodically:

1. Inspect the terminals for corrosion and loose connections. Reseal any exposed electrical connections with Liquid Neoprene.



Starter electrical connections

- a - Starter solenoid
- b - Positive (red) cable
- c - 90-amp fuse
- d - Negative (black) cable
- e - Rubber boot

29190

Tube Ref No.	Description	Where Used	Part No.
 25 	Liquid Neoprene	Electrical connections	92- 25711 3

2. Inspect the wiring for frayed or worn insulation.
3. Tighten the starter mounting bolts to the specified torque.

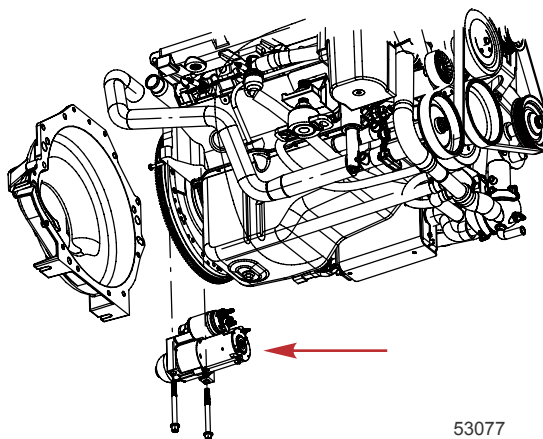
Description	Nm	lb-in.	lb-ft
Starter mounting bolts	47.5	–	35

Starter Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect the battery cables from the battery. Remove the negative (–) cable first.
2. Disconnect the wires from the solenoid terminals.
3. Remove the starter mounting bolts.
4. Pull the starter assembly away from the flywheel and remove it from the engine.



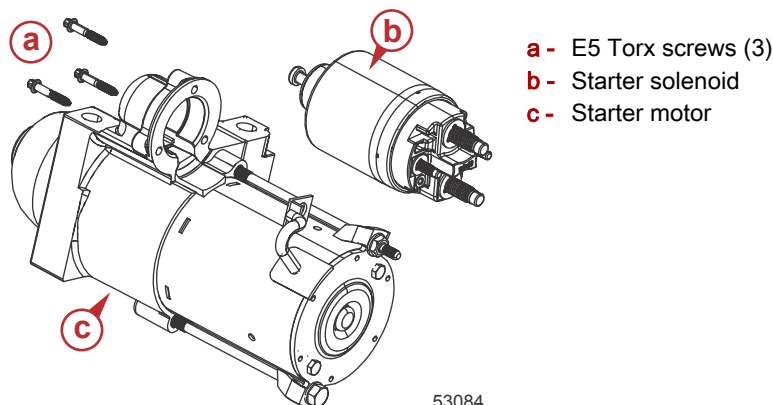
53077

Starter Solenoid

Removal

1. Disconnect the jumper between the starter motor and solenoid by removing the nut on the lower solenoid stud.

- Using an E5 Torx socket, remove the screws retaining the solenoid to the starter.



- Remove the solenoid from the drive housing.

Installation

- Set the solenoid in position on top of the starter housing.
- Insert the E5 Torx screws into the mounting holes and tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Starter solenoid mounting screws, E5 Torx	4.0–4.5	35–40	–

- Attach the jumper wire from the drive housing to the lower stud on the solenoid. Secure it with the previously removed nut.

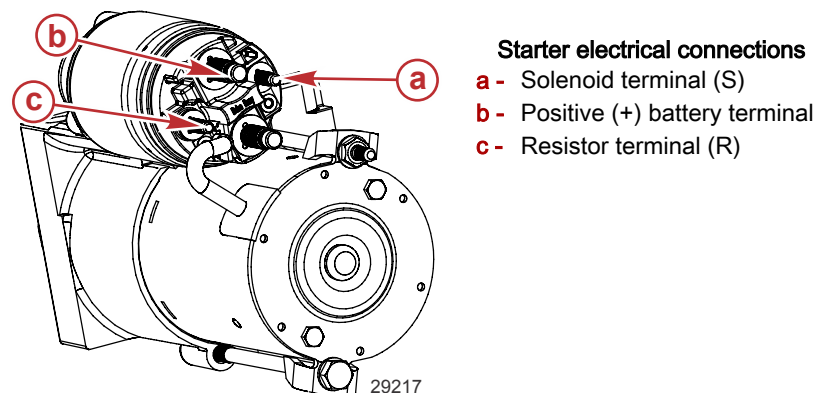
Starter Installation

IMPORTANT: The special mounting shim (if equipped) installed between the starter motor and the engine block must be reused.

- Place the starter motor into position and install the mounting bolts. Tighten the starter mounting bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Starter mounting bolts	47.5	–	35

- Connect the yellow/red wire to the solenoid's "S" terminal. Tighten the terminal nut to the specified torque.



Starter electrical connections

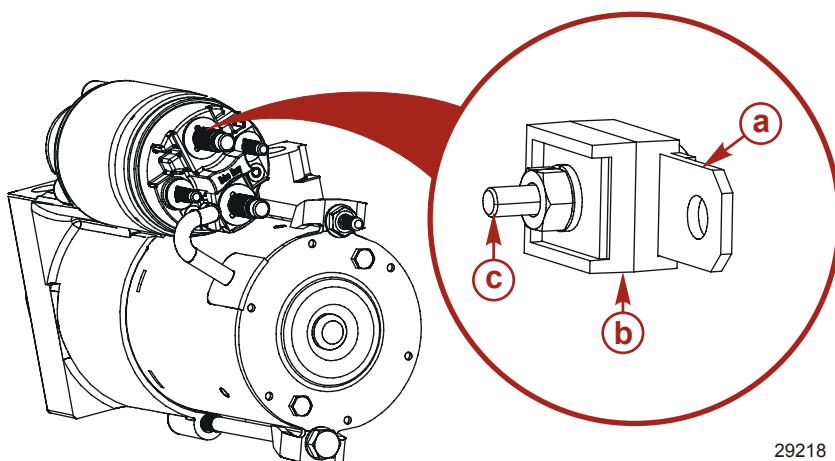
- a - Solenoid terminal (S)
- b - Positive (+) battery terminal
- c - Resistor terminal (R)

Description	Nm	lb-in.	lb-ft
Solenoid (S) terminal nut	2	18	–

- Connect the positive (+) battery cable and the 90-amp fuse to the battery terminal. Tighten the terminal nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Battery terminal nut	9.5	84	–

- Connect the orange (alternator) wire and the red wire to the post on the 90-amp fuse, which is located on the starter positive (+) battery terminal. Securely tighten the terminal nut.



- a - Starter terminal
b - Insulator
c - Positive (+) battery connection

29218

NOTE: The back of the fuse is an insulator. Do not connect any wires to the back of the fuse.

- Coat all terminals with Liquid Neoprene.

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Electrical connections	92- 25711 3

- Install the battery cable boot, if equipped.
- Connect the positive (+) battery cable to the positive (+) battery terminal and tighten the cable clamp.
- Connect the negative (-) battery cable to the negative (-) battery terminal and tighten the clamp.

Starting System Tests

Low power-supply voltage and water contamination are the primary causes of most starter motor failures. Low power-supply voltage causes excessive heat to build up in the starter motor. It can also cause starter motor solenoid contact problems.

IMPORTANT: Perform these tests before removing the starter from the engine.

Use a digital multimeter to conduct the tests. Analog meters can be damaged by voltage spikes generated in the starter motor windings.

DMT 2004 Digital Multimeter	91-892647A01
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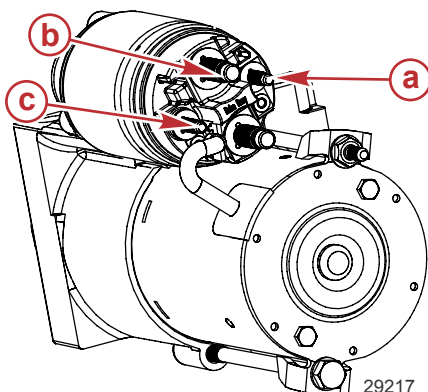
Low Voltage Tests

If the engine does not crank, or cranks slowly, use a digital multimeter to verify that at least 9.5 volts are available to the starter motor.

- Ensure that the battery is fully charged.

NOTE: The voltage measured at the posts of a fully charged battery will typically read around 12.7 volts.

- Remove the coil wire from the distributor cap and ground it to prevent the engine from starting.
- Remove the fuse from the fuel pump circuit to prevent fuel from flooding the cylinders, which could result in mechanical damage.
- Set the multimeter to VDC and connect the positive (+) meter lead directly to the starter's positive (+) battery terminal.



Starter electrical connections

- a - Solenoid terminal (S)
b - Positive (+) battery terminal
c - Resistor terminal (R), not used

29217

5. Connect the negative (–) meter lead directly to an unpainted metal surface on the starter housing.
6. Crank the engine over with the key switch for 10–15 seconds while observing the voltmeter.
 - A reading of 9.5 volts or more indicates that the battery is supplying sufficient voltage to the starter to operate properly. If the starter does not function properly, the starter or the engine are malfunctioning. Remove the spark plugs and try turning the engine over by hand to rule out an engine problem.
 - A reading below 9.5 volts indicates too much voltage loss between the battery and the starter motor. Check all components between the starter motor and the battery for damage, wear, and proper application. If no obvious defects are spotted, complete the **Voltage Drop Test**.

Verify that at least 9.5 volts are available to the solenoid at terminal "S," during cranking. Low voltage at the starter solenoid can cause intermittent operation of the solenoid contacts and shorten the life of the solenoid.

1. Connect the positive (+) voltmeter lead to terminal "S" on the starter solenoid (yellow/red wire from the starter relay).
2. Connect the negative (–) voltmeter lead to an unpainted surface of the starter housing.
3. Crank the engine over and observe the voltmeter. If the reading is less than 9.5 volts, there could be an issue with the starter relay, the yellow/red wire that connects the relay to the solenoid, or the circuit that supplies the voltage to terminal 87 of the relay (refer to **14-Pin Starting Circuit** for circuit details).

Voltage Drop Test

The voltage drop test is used to identify areas of high resistance within the battery circuit. High resistance can result from loose connections, undersized cables, corrosion, or other imperfections in the starting circuit. Each area of high resistance acts as a small load on the starting circuit, reducing the voltage intended for energizing the starter motor. The net result is a sluggish starter.

As you perform this test, remember that voltage drops are additive. Identify and correct the worst areas, seeking to reduce the cumulative voltage drop to the point where 9.5 volts (or more) are available to the starter motor.

1. Test the battery positive (+) cable first:
 - a. Connect the voltmeter positive (+) lead directly to the positive (+) post of the battery. Do not use the battery cable terminal. Connect the voltmeter negative (–) lead directly to the large, threaded starter motor positive (+) terminal to which the battery positive (+) cable is connected.
 - b. Crank the engine over while observing the voltmeter. The voltage displayed on the meter is the voltage drop. It will normally be 0.3 volts or less; if it is higher, the battery cable might be undersized. If the drop is excessive, test the connections at the ends of the cable:
 - To find the point where the resistance is highest, leave the voltmeter positive (+) lead on the battery post and move the voltmeter negative (–) lead to the battery positive (+) cable ring terminal, which is on the threaded starter terminal. Crank engine while observing voltmeter.
 - Move the voltmeter negative (–) lead to the battery cable itself, which is inside the crimped battery cable ring terminal.
 - Continue to test each battery cable connection back to the battery positive (+) post until the source of the excessive voltage drop is found.
 - c. If a battery switch is used, check between the battery cable ring terminal and the switch's terminal.
2. Check for voltage drop across the solenoid contacts:
 - a. Connect the positive (+) voltmeter lead to the large, threaded starter motor positive (+) terminal to which the battery positive (+) cable is connected. Connect the negative (–) meter lead to the lower stud on the solenoid.
 - b. Crank the engine over while observing the voltmeter. The voltage drop should be 0.2 volts or less; if it is higher, the contacts are likely dirty or damaged.
3. Check for voltage drop from the starter mounting bolt to the engine ground stud:
 - a. Connect the positive (+) voltmeter lead to a starter mounting bolt. Connect the negative (–) meter lead to the engine ground stud.
 - b. Crank the engine over while observing the voltmeter. The voltage drop should be 0.2 volts or less; if it is higher, remove the starter and clean the mating surface. Reinstall the starter and retest.
4. Check for voltage drop on the battery negative (–) cable:
 - a. Connect the voltmeter negative (–) lead directly to the battery negative (–) post, not the battery cable ring terminal. Connect the voltmeter positive (+) lead to an unpainted surface of the starter housing.
 - b. Crank the engine over while observing the voltmeter.
IMPORTANT: The maximum allowed drop is 0.3 volts.
 - c. To find the point where the resistance is highest, leave the voltmeter negative (–) lead on the battery negative (–) post and move the voltmeter positive (+) lead to the ground stud where the battery negative (–) cable is connected.
 - d. Move the voltmeter negative (–) lead to the battery negative (–) cable ring terminal that is on the ground stud.

- e. Move the voltmeter positive (+) lead to the battery cable itself, which is inside the crimped battery cable ring terminal.
- f. Test each battery cable connection in this manner back to the battery post until the source of the excessive voltage drop is located.

Water and Corrosion Inspection

Remove the two short screws from the starter motor end cap and inspect the threads.

- If they are clean and gold in color, the starter motor has not had water inside of it.
- If they are dirty and discolored the starter motor may have water contamination and should be replaced.

IMPORTANT: Starter damage caused by water contamination is not covered by the Mercury MerCruiser warranty.

Notes:

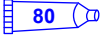
Electrical System

Section 4B - Ignition System

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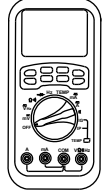
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Key	92-809819
		Keyway	
 25	Liquid Neoprene	High tension wire coil tower	92- 25711 3
		Outside rim of the coil wire tower	
		Electrical terminals	
 80	SAE Engine Oil 30W	Distributor shaft	Obtain Locally

Special Tools

Timing Light	91-99379
 11561	Allows a technician to check ignition timing.

Idle mixture adjustment tool	91-863375A1
 25739	Use to adjust the idle mixture on models produced prior to January 1, 2003.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Torch Lamp	91-63209
 8776	Heats surfaces to aid in the removal and installation of interference fit engine components.

MPI Ignition System

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Torque Specifications

NOTE: Securely tighten all fasteners not listed below.

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	30	–	22
Spark plugs (used cylinder head)	14	132	–
Distributor clamping screw	24.5	–	18
Knock sensor	19	–	14

MPI Ignition Specifications

Coil

Description	Specification
Primary coil resistance	0.60–0.80 Ω
Secondary coil resistance	9,400–11,700 Ω

Firing Order and Ignition Timing

Description	Specification
Firing order	1-6-5-4-3-2
Ignition timing	PCM

Ignition Troubleshooting High Voltage Switch (HVS)

Step	Action	Values	Yes	No
1	Connect the computer diagnostic system (CDS).	—		
2	Connect a Coast Guard approved spark gap tester to the high tension lead from the coil.	—		
3	Disable the fuel pump to prevent hydro locking the engine during the following test.	—		
4	Open the data items located in the tool box icon and monitor the RPM line while the key is in the start position to see if the ECM is receiving a CPS signal. NOTE: If the voltage drops too low during this test, the CDS screen will freeze at 0 RPM.	RPM shown	Go to step 9	Go to step 5
5	Open the active diagnostic located in the tool box icon. Perform the ignition test (plugs out of head) and check for spark.	Spark present	Go to step 6	Go to step 9
6	Refer to MerCruiser Service Bulletin 2011-08R1 before proceeding to step 7.	—		
7	Check for reference voltage at the CPS connection. Verify 5.0–5.2 VDC between the gray and black/pink. Verify 4.6–4.8 VDC between the tan/black and black/pink.	Voltage present	Go to step 8	Check ECM wiring
8	Simulate an RPM by using the pin probe (J-35616-2A) from your CDS probe kit and a suitable jumper wire. Being careful not to damage the CPS connector insert pin probe (J-35616-2A) with the jumper lead attached to the tan/black wire (CPS signal terminal C) and rapidly strike jumper wire to ground and watch for spark.	Spark present	Replace CPS	Check ECM wiring
9	Set your digital voltmeter (DVM) to volt DC.	—		
10	Turn the key switch to the on position and check for battery voltage on the pink/white wire going to the ignition coil driver (pin A).	Battery voltage	Go to step 11	Check fuse and wiring from fuse
11	With the key switch still in the on position check for battery voltage on the pink/white wire (pin A) going to the ignition coil.	Battery voltage	Go to step 12	Check fuse and wiring from fuse
12	Verify good continuity between the black wire going to the ignition coil driver (pin C) and a good engine ground.	Continuity	Go to step 13	Check for broken wire
13	Check for 4.5 VDC on the white/dark green wire going to the ignition coil driver (pin B).	4.5 VDC	Go to step 14	Check ECM or wiring issue
14	Set your DVM to the hertz setting.	—		
15	With the DVM still connected to the white/dark green wire (pin B) and a good engine ground move the key switch to the start position and look for a frequency present.	A frequency	Go to step 16	Check for ECM, CPS or wiring issue
16	Reconnect the ignition coil driver harness and move the positive DMV lead to the white/light green wire on the wire going to the ignition coil (pin B, C). Move the key switch into the start position and look for a frequency present.	A frequency	Ignition coil has failed	Ignition coil driver has failed or wiring issue

NOTE: The ignition coil driver and ignition coil are replaced as an assembly.

Notes:



Distributor and Ignition Components (MPI)

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Distributor				
2	1	Distributor cap				
3	2	Screw				
4	1	Rotor				
5	2	Screw				
6	1	Sensor				
7	2	Screw				
8	1	Gear assembly				
9	1	Clamp				
10	1	Screw (0.375-16 x 1.00)		25	–	18
11	1	Gasket				
12	1	Ignition wires				
13	1	Coil wire				
14	6	Spark plug	New install	30	–	22
			Used install	15	133	–
15	2	Two wire retainer				
16	2	Three wire retainer				
17	2	Four wire retainer				
18	1	Coil				
19	2	Screw with lockwasher (0.250-20 x 0.625)		12	106	–
20	1	Bracket				
21	2	Screw (0.375-16 x 0.750)				
22	2	Stud				
23	2	Retainer				

Spark Plug Removal, Inspection, and Installation

Engine	OEM Spark Plug	Mercury Part Number	Gap
4.3 MPI	AC Delco 41-101	8M2018369 NGK ITR4A15	1.5 mm (0.060 in.)

Removal

1. Disconnect the spark plug wires from the spark plugs.
NOTE: Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot, not the wire.
2. Remove the spark plugs.
NOTE: A thin-walled spark plug socket may be required.

Inspection

1. Examine each spark plug. All plugs must be from the same manufacturer and have the same spark plug number.
2. Inspect each plug for worn electrodes and for glazed, broken, or blistered porcelain. Check the joint between the insulator and the shell for cracks. Replace as necessary.

Installation

1. Clean the cylinder head spark plug seat.
2. Adjust the spark plug gap with the appropriately sized, round-tipped feeler gauge.
IMPORTANT: In the absence of a torque wrench or if limited access prevents the use of a torque wrench, hand-tighten the spark plugs until they seat in the cylinder head and then securely tighten with the appropriate ratchet and socket.
3. Install the spark plugs and tighten them to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	30	–	22
Spark plugs (used cylinder head)	15	133	–

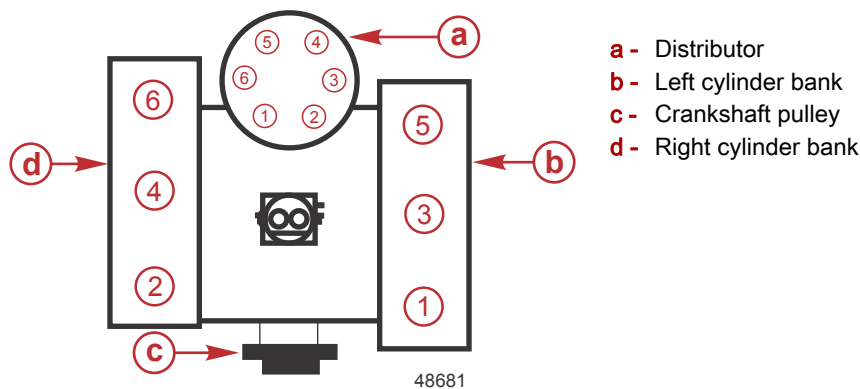
4. Install the spark plug wires in the proper order. Refer to **Spark Plug Wire Installation** for details.

Spark Plug Wire Installation

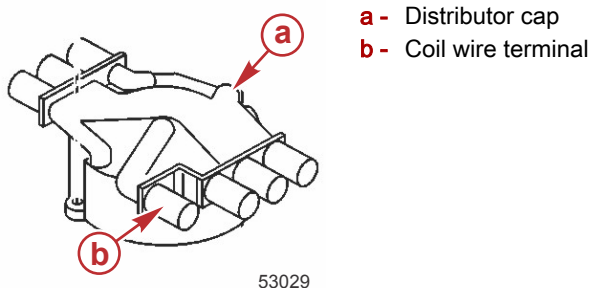
IMPORTANT: Only use spark plug wires recommended for marine applications.

NOTE: Replace one spark plug wire at a time to reduce the risk of a routing error.

1. Disconnect each individual spark plug wire in the proper order.
2. Install the replacement spark plug wires in the proper order. Observe the following:
 - a. Reinstall the wires in the spark plug wire retainers.
 - b. Attach the plug wires to the appropriate spark plug and terminal on the distributor cap. Each end should fit securely.



Description	Specification
Firing order	1-6-5-4-3-2



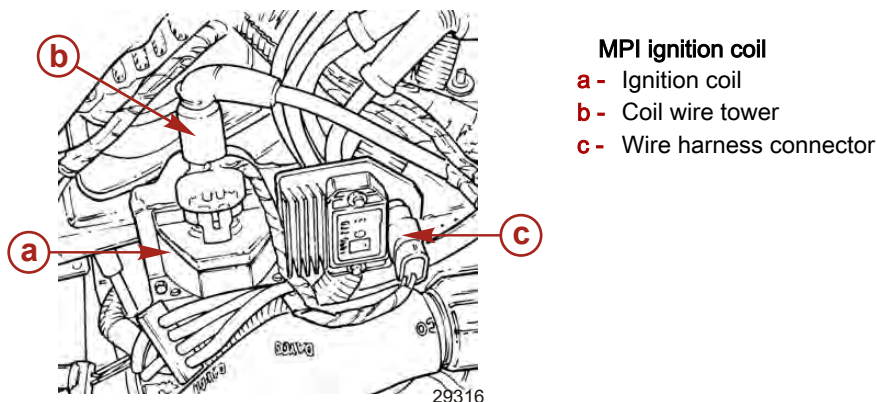
3. Apply sealant to the outside of the high tension wire coil tower. Insert the coil wire (high tension lead) into the terminal on the distributor cap that is marked with a C, then push the boot down over the coil tower and wipe off excess sealant.

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	High tension wire coil tower	92- 25711 3

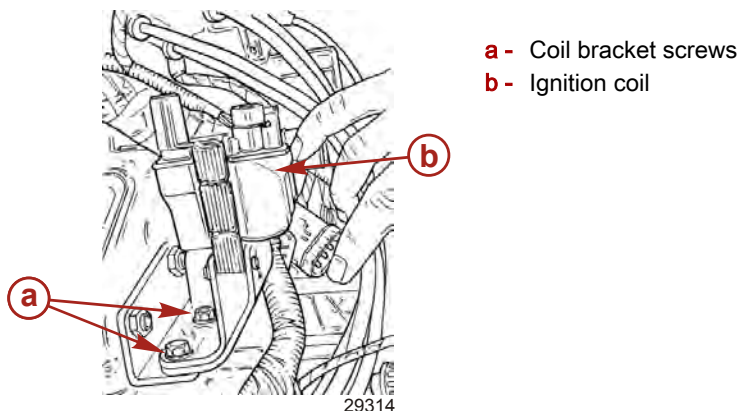
NOTE: Ensure that the high tension wire boot does not come loose when pushing the wire into the terminal.

Coil Removal

1. Disconnect the wire harness connectors at the ignition coil.



2. Remove the coil wire.
3. Remove the coil bracket screws and bracket with the ignition coil.

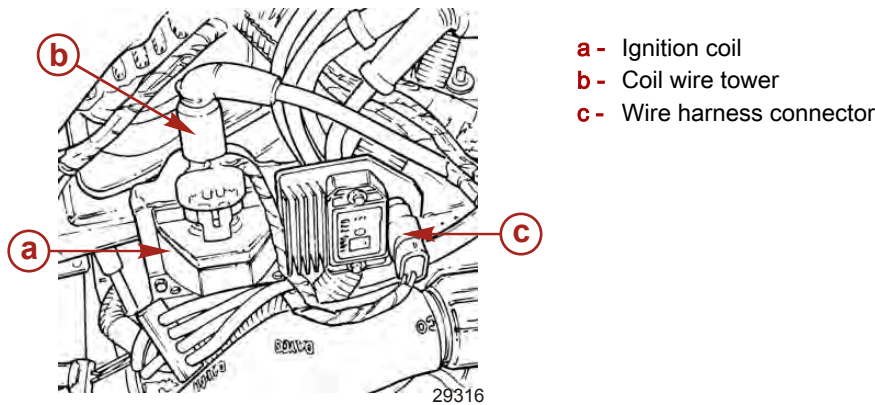


4. Remove the ignition coil from the coil bracket.

Coil Installation

1. Install the ignition coil and bracket onto the engine bracket.

- 2. Apply a thin bead of sealant around the outside rim of the coil wire tower.

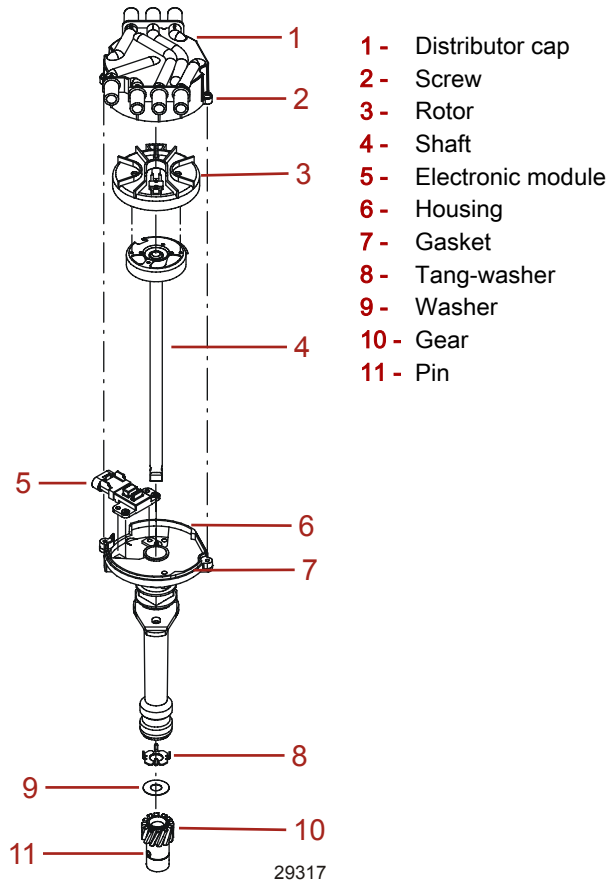


Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Outside rim of the coil wire tower	92- 25711 3

IMPORTANT: Ensure that sealant is not applied inside the coil wire tower.

- 3. Connect the coil wire.
- 4. Connect the wire harness connector.

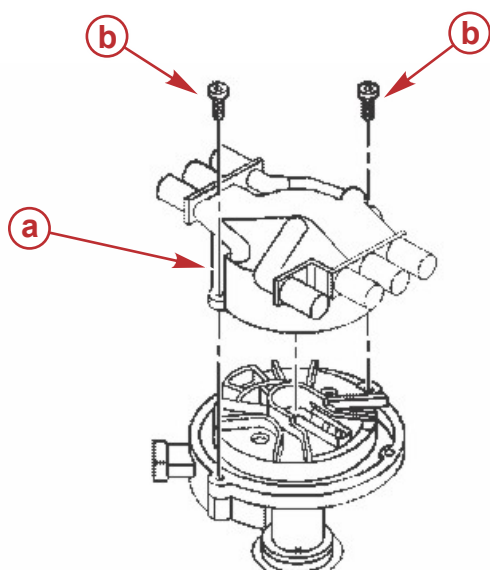
MPI Distributor Exploded View



Distributor Cap Removal

- 1. Label and remove all spark plug wires from the distributor cap.
- 2. Loosen the distributor cap retaining screws.

- Lift the cap away from the distributor.



MPI distributor cap

a - Distributor cap

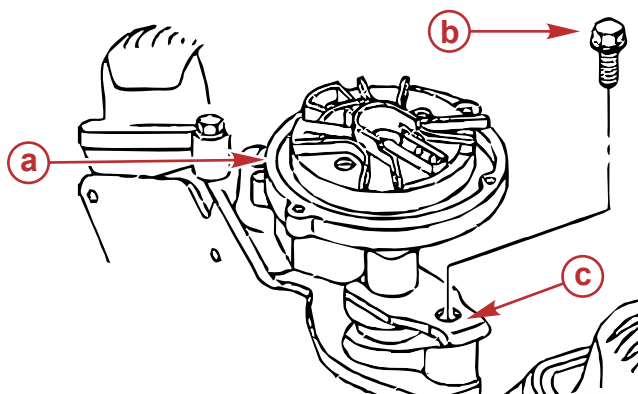
b - Screws (2)

52637

- Inspect the distributor cap for cracks or carbon tracking. Replace the distributor cap if it shows any sign of damage, corrosion, or if the inner electrical contacts show signs of erosive wear.
- Inspect the rotor for cracks or carbon buildup. Replace the rotor if it shows any sign of damage, corrosion, or if the inner electrical contact shows any sign of erosive wear.

MPI Distributor Removal

- Label and remove the spark plug wires.
- Remove the two screws fastening the distributor cap to the distributor.
- Remove the distributor cap. Do not remove the high tension lead unless necessary.
- Make indexing reference marks on the distributor housing and engine block.
- Remove the bolt and hold down clamp.



a - Distributor

b - Hold down bolt

c - Hold down bracket

29320

- Remove the distributor and the gasket from the intake manifold.

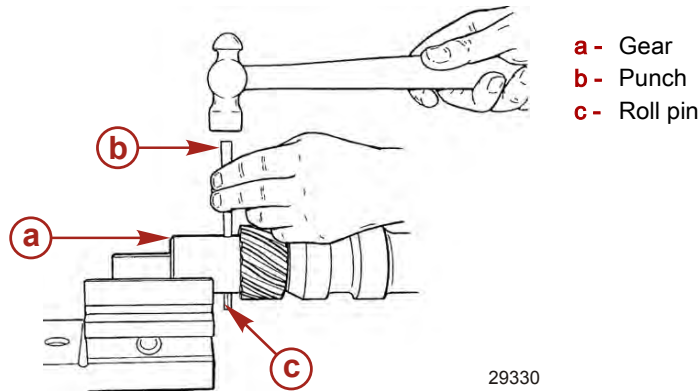
IMPORTANT: To ease installation, do not turn the engine over while the distributor is removed.

MPI Distributor Disassembly

- Remove the two Torx screws attaching the rotor to the distributor.

Ignition System

2. Remove the rotor from the distributor shaft.



3. Remove the roll pin, washer, and drive gear from the distributor shaft.
4. Check for side play between the shaft and distributor housing bushings.

Description	Specification
Distributor shaft to housing side play	0.05 mm (0.002 in.) maximum

5. Remove the shaft from the housing.
6. Check the distributor shaft runout with a dial indicator and V-blocks.

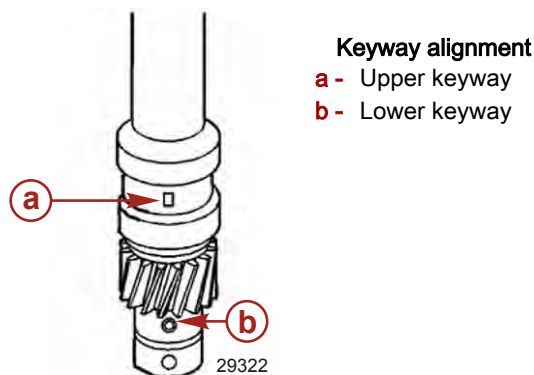
Description	Specification
Distributor shaft runout	0.05 mm (0.002 in.) maximum

Distributor Assembly

1. Lubricate the distributor shaft with engine oil, and install the shaft into the housing.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Distributor shaft	Obtain Locally

2. Install the tang washer, the washer, and the drive gear onto the shaft.
3. Temporarily install the rotor on the shaft. Using the scribe marks made during distributor removal, align the drive gear, the housing, and the rotor.
4. Install the roll pin through the drive gear and the distributor shaft.
5. Spin the distributor shaft to ensure that it spins freely.
6. Align the distributor shaft keyways.

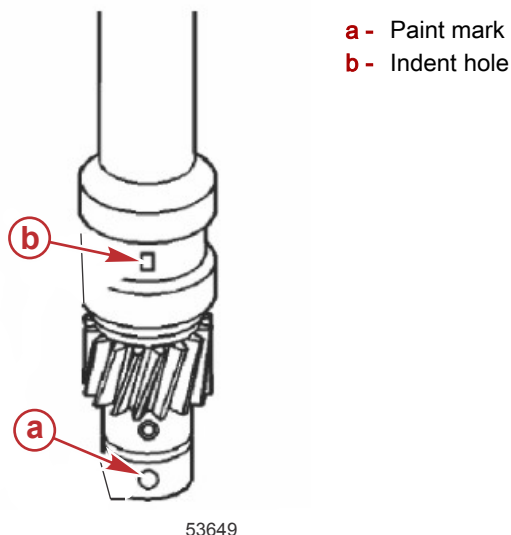


7. Install the rotor onto the distributor shaft. The rotor tang must be aligned with the scribe marks made during distributor removal.

MPI Distributor Installation

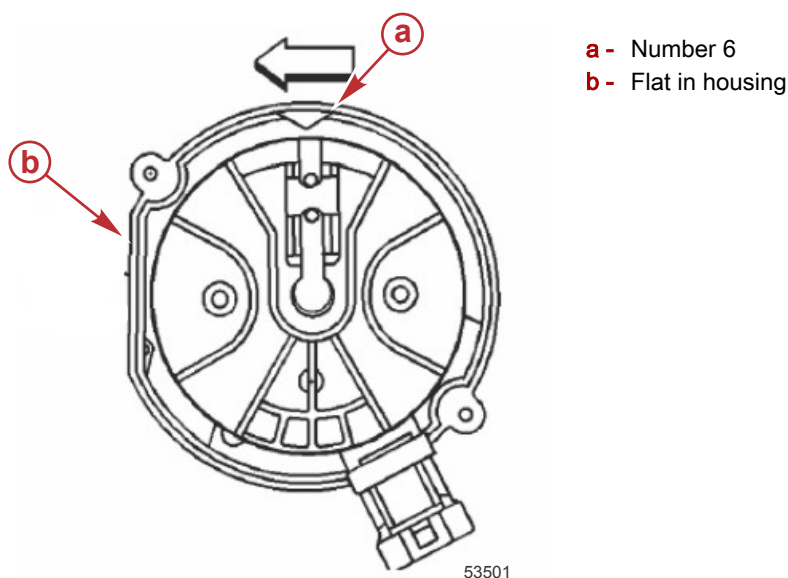
1. Verify that cylinder No. 1 is at TDC. If not, follow either of the following methods to position cylinder No. 1 at TDC:
IMPORTANT: Do not insert anything into a spark plug hole while turning the engine over.

- a. Remove the No. 1 spark plug. Attach a suitable socket and drive to the crankshaft pulley nut. Place a finger over the plug hole and turn the engine over by hand until compression is felt in the No. 1 cylinder. Continue turning the engine over by hand until the block mounted timing pointer aligns with the timing mark on the crankshaft pulley.
 - b. Attach a suitable socket and drive to the crankshaft pulley nut. Remove the left (when observed from the rear of the engine) rocker cover and turn the engine over by hand until the No. 1 cylinder intake valve is fully closed. Continue turning the engine over by hand until the block mounted timing pointer aligns with the timing mark on the crankshaft pulley.
2. Install a new gasket on the distributor housing.

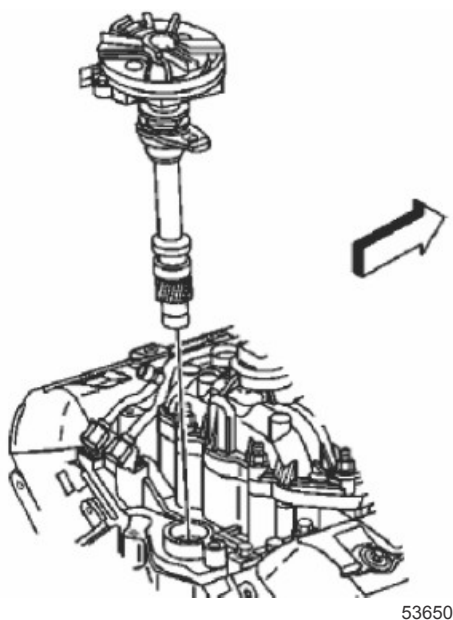


3. Align the indent hole on the driven gear with the paint mark on the distributor housing.
4. Ensure that the distributor rotor segment points to the cap hold area.
5. Align the slotted tang in the oil pump driveshaft with the distributor driveshaft. Rotate the oil pump driveshaft with a screwdriver if necessary.

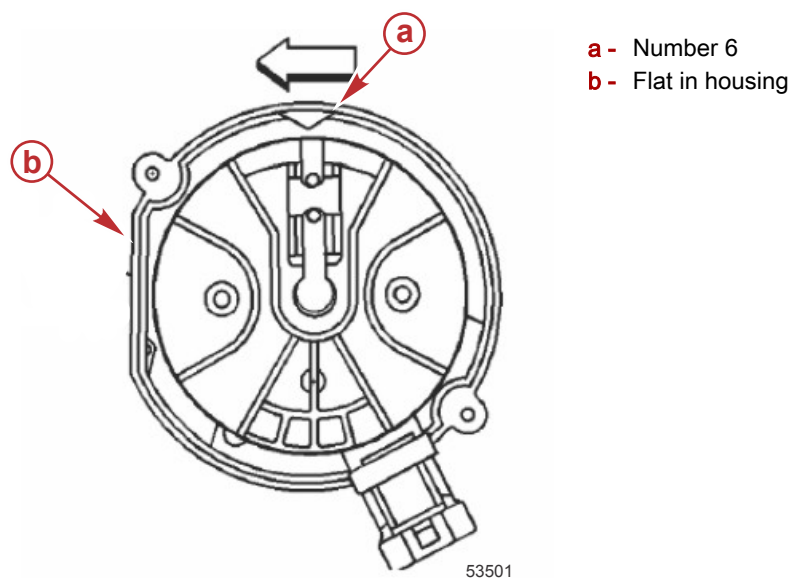
IMPORTANT: Ensure that the oil pump shaft is properly engaged. If the engine has been turned over after disassembly it may be necessary to reposition the oil pump shaft.



6. Align the flat in the distributor housing toward the front of the engine.

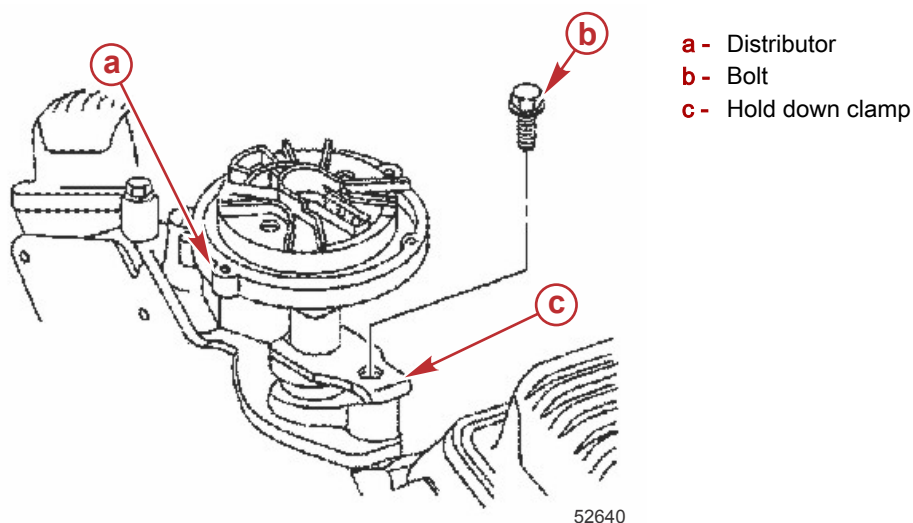


7. Install the distributor and distributor clamp. The flat in the distributor housing must point toward the front of the engine.



8. Once the distributor is fully seated, align the distributor rotor segment with the number 6 pointer that is cast into the distributor base. If the distributor rotor segment does not come within a few degrees of the number 6 pointer, the gear mesh between the distributor and camshaft may be off a tooth or more. Repeat the procedure again in order to achieve proper alignment.

9. When properly installed, the distributor housing is in full contact with the machined relief in the intake manifold.



10. Install the hold down clamp over the distributor and tighten the bolt to the specified torque.

Description	Nm	lb-in.	lb-ft
Distributor hold down clamp bolt	24.5	–	18

11. Connect all ignition control wiring.
 12. Install the distributor cap.
 13. Connect the spark plug wires. Remove any temporary plug wire labeling once all wires have been installed and routing confirmed.

TKS Thunderbolt V Ignition System

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

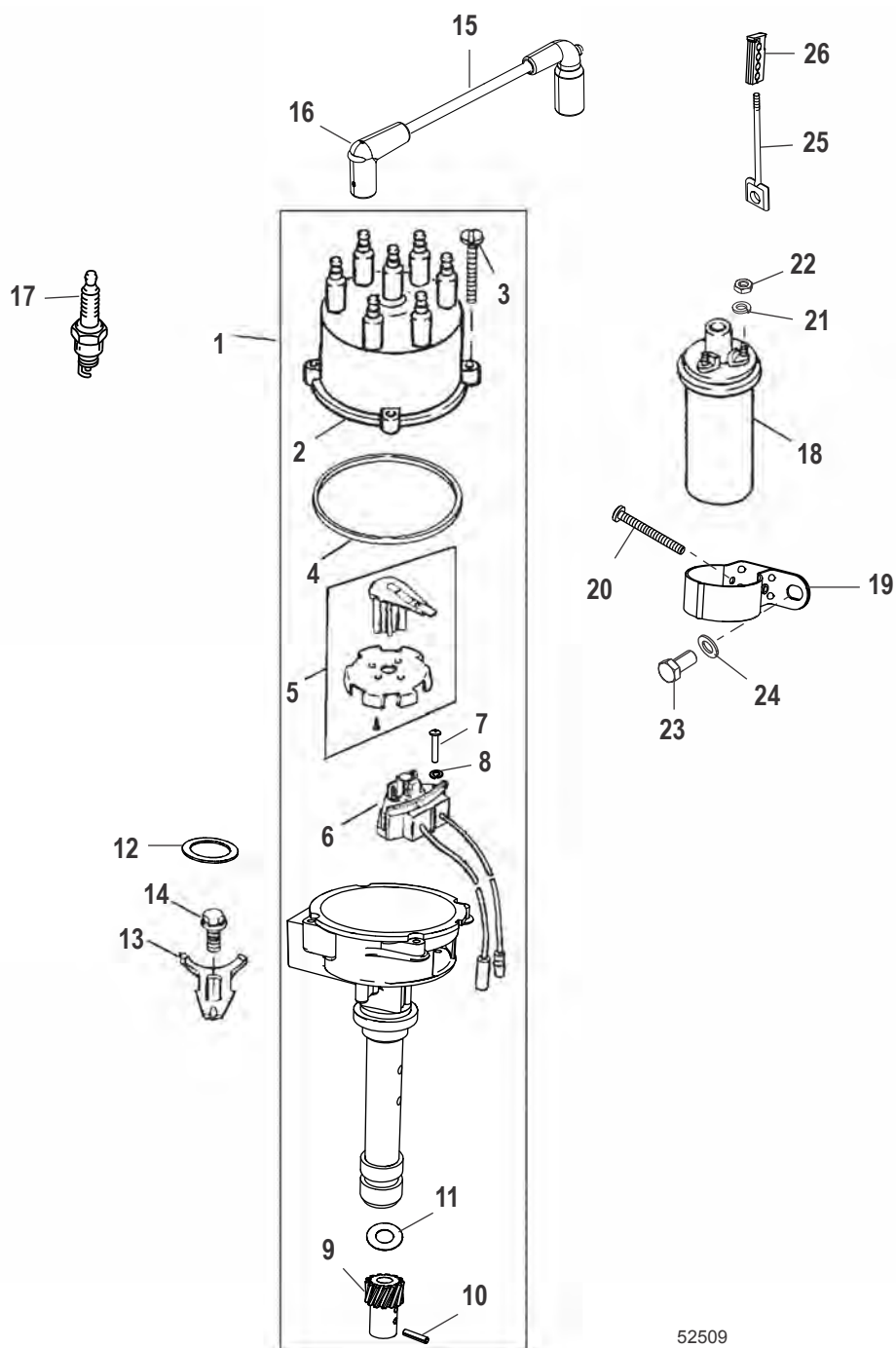
Troubleshooting Thunderbolt V Ignition

Step	Action	Values	Yes	No
1	Check to ensure that the tachometer gray lead is not shorted to ground (–) at the tachometer or within the harness.	No Spark	Go to step 2	
2	Check all the terminal connections at distributor, ignition module, and ignition coil. Battery OK, distributor clamping screw tight?	No Spark	Go to step 3	
3	With the key in the run position, check for 12 V at the positive (+) terminal on the ignition coil.	12 V	Go to step 4	Check engine and instrument wiring harness, battery cables, key switch
4	Unplug the white/red bullet connector from the distributor. Check for 12 V on the lead coming from the module.	12 V	Go to step 5	Replace ignition module
5	Reconnect the white/red bullet connectors. Remove the high-tension lead from the distributor to the coil. Insert a spark gap tester from the coil tower to the ground. Disconnect the white/green lead from the distributor. Place the ignition key in the run position. Rapidly strike the terminal of the white/green lead that comes from module, against ground (–). (Refer to Important below.)	Spark at coil	Replace ignition sensor in distributor	Go to step 6
6	Substitute a new ignition coil. Repeat the above test.	Spark at coil	Install new ignition coil	Replace ignition module

IMPORTANT: The white/green lead must be touched against ground (–) 2–3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

Notes:

Distributor and Ignition Components (TKS)



Distributor and Ignition Components (TKS)

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Distributor assembly				
2	1	Distributor cap				
3	4	Screw (#10-32 x 0.810)				
4	1	Gasket				
5	1	Rotor				
6	1	Sensor				
7	2	Screw (#10-32 x 1.25)				
8	2	Lockwasher				
9	1	Gear				
10	1	Pin				
11	1	Thrust washer				
12	1	Gasket				
13	1	Clamp				
14	1	Screw		34	–	25
15	1	Ignition wires				
16	1	Coil wire (NSS)				
17	6	Spark plug	New install	30	–	22
			Used install	15	133	–
18	1	Coil				
19	1	Bracket				
20	1	Screw				
21	2	Lockwasher (stainless steel)				
22	2	Nut (stainless steel)				
23	1	Screw (0.375-16 x 0.750)				
24	2	Washer (0.406 x 0.734 x 0.063)				
25	2	Stud				
26	2	Retainer				

Spark Plug Wire Removal

1. Disconnect the spark plug wires (high tension leads) from the spark plugs.

NOTE: Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot, not the wire.

2. Remove the spark plugs.

NOTE: A thin-walled spark plug socket may be required.

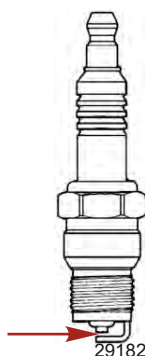
Spark Plug Wire Inspection

NOTE: Use care when removing the spark plug wires and the boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot to remove the wire.

1. Visually inspect the spark plug wires and the coil wire for damage.
2. Visually inspect the spark plug boots for damage.
3. Check the spark plug wires and the coil wire for continuity using a multimeter.
4. Replace any damaged wires.

Spark Plug Inspection

1. Inspect each spark plug for the manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number.



Spark plug gap

Engine	OEM Spark Plug	Mercury Part Number	Gap
Carbureted 4.3 TKS	AC 41-101	862029 AC MR43LTS	1.14 mm (0.045 in.)

2. Inspect each plug individually for worn electrodes and for glazed, broken, or blistered porcelain. Check the joint between the insulator and the shell for cracks. Replace as necessary.

Spark Plug Installation

1. Clean the cylinder head spark plug seat.
2. Adjust the spark plug gap with the appropriately sized round-tipped feeler gauge.

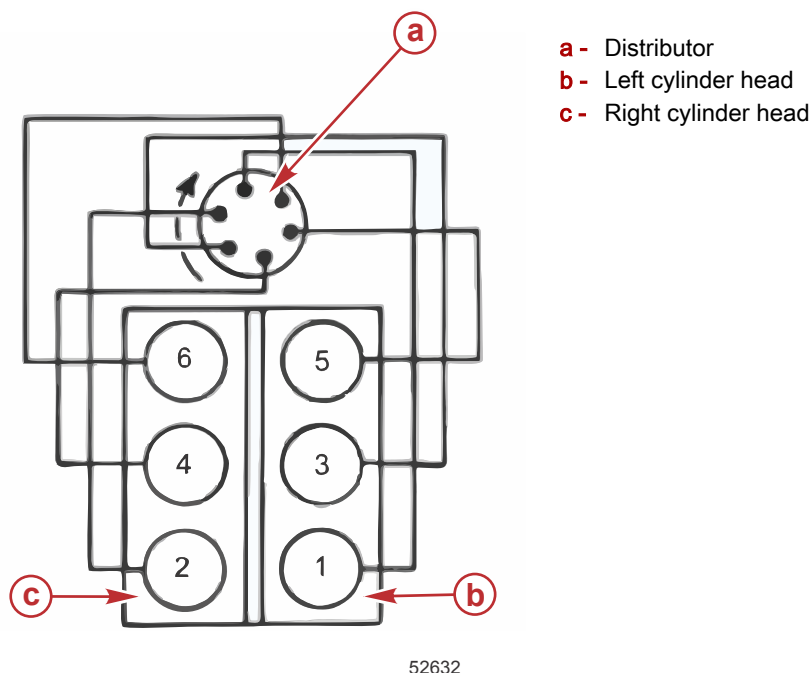
Engine	OEM Spark Plug	Mercury Part Number	Gap
Carbureted 4.3 TKS	AC 41-101	862029 AC MR43LTS	1.14 mm (0.045 in.)

IMPORTANT: In the absence of a torque wrench or if access to the plugs prevents torquing, hand-tighten the spark plugs until they seat in the cylinder head and then securely tightened with the appropriate ratchet and socket.

3. Install the spark plugs and tighten them to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	30	–	22
Spark plugs (used cylinder head)	15	133	–

4. Install the spark plug wires in the proper order.



Description	Specification
Firing order	1-6-5-4-3-2

Thunderbolt V Models Timing

1. Connect the timing light to No. 1 spark plug wire.

Timing Light	91-99379
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2. Connect a shop tachometer to the engine.
IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned to the "ON" position to lock the ignition module into Base Timing Mode.
3. Before starting the engine, connect a jumper wire from the timing lead to a good ground.
NOTE: The purple/white timing lead is located towards the front of the engine near the fuel line or near the distributor, as equipped for your model.
4. Start the engine and operate it at 1300 RPM until it reaches normal operating temperature.
5. Disconnect the throttle cable from the carburetor.
6. With the engine at idle RPM, adjust the carburetor idle RPM screw to the specified engine idle RPM for your model.
7. With the engine still at idle RPM, check the ignition timing. If it is incorrect, rotate the distributor housing until the timing is correct.

Description	Nm	lb-in.	lb-ft
Distributor clamp bolt	24.5	–	18

IMPORTANT: The idle mixture screw is adjustable on models produced prior to January 1, 2003.

8. Check the idle RPM. If it is out of specification, adjust the idle mixture screw. Adjusting the idle mixture screw inward will lean the air-to-fuel ratio and adjusting it outward will enrich the air-to-fuel ratio.

Idle mixture adjustment tool	91-863375A1
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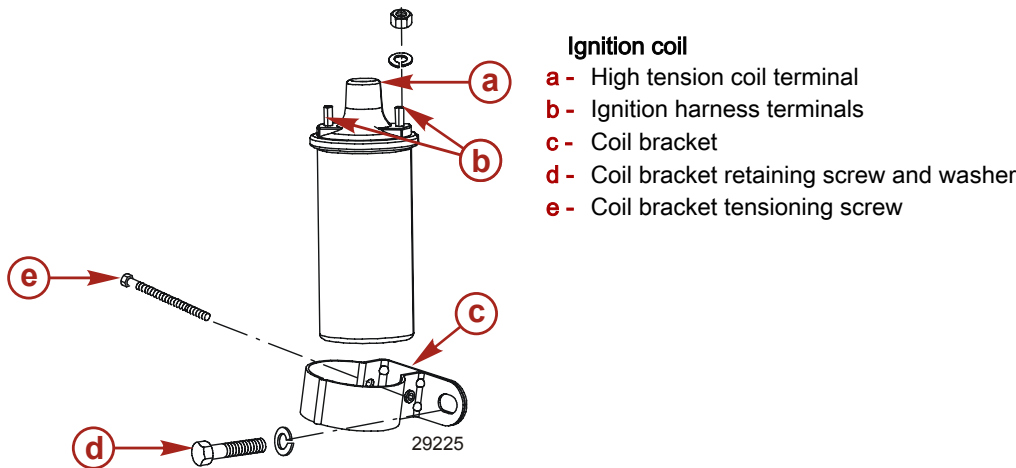
9. Recheck the ignition timing.
IMPORTANT: The timing jumper wire has to be removed or the ignition module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine RPM is increased.
10. Stop the engine. Remove the timing light, jumper wire, and shop tachometer.
11. Reinstall and adjust the throttle cable. Open and close the remote control throttle lever to ensure that the carburetor's throttle lever returns against the RPM adjusting screw every time.

Ignition System

- 12. Restart the engine, increase the RPM to 1300, and return to idle position slowly. Ensure that the carburetor throttle lever returns against the idle RPM screw.
- 13. Shut the engine off.

Coil Removal

- 1. Disconnect the wire harness connectors at the ignition coil.

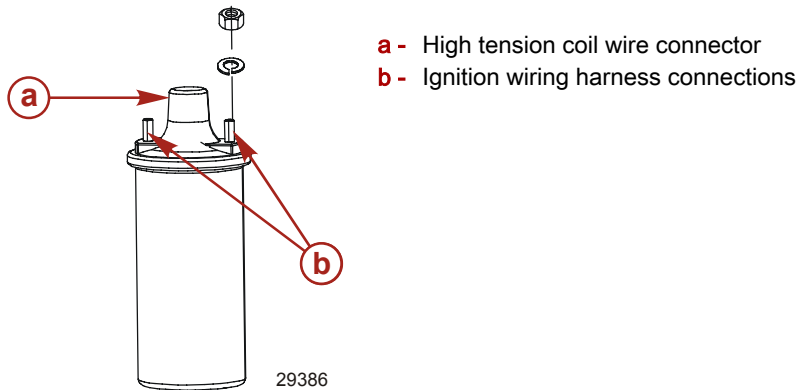


- 2. Remove the high tension coil lead.
- 3. Remove the coil bracket fasteners and bracket with the ignition coil.
- 4. Remove the ignition coil from the coil bracket.

Ignition Coil Testing

NOTE: Readings listed are taken at 20 °C (68 °F) with a digital ohmmeter. Due to the number of different manufactures of meters available and temperature variance, test results may vary.

- 1. Disconnect the ignition coil from the engine harness connector.
- 2. Remove the ignition coil high tension lead from the spark plug.



- 3. Check the resistance of the coil primary windings to engine ground. Replace the ignition coil if not within specification.

DMT 2004 Digital Multimeter		91-892647A01	
Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Coil primary lead	Coil mounting bolt	Auto range	0.17 - 0.23

- 4. Hold the high tension lead and rotate the spark plug cap counterclockwise. Remove the spark plug cap from the spark plug high tension wire.
- 5. Measure the resistance of the ignition coil secondary winding to engine ground. Replace the ignition coil if not within specification.

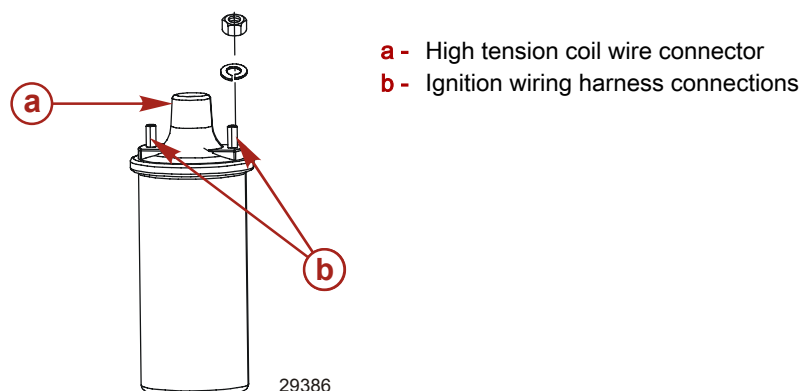
Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Coil high tension lead	Engine ground	Auto range	3.3 - 4.9k

Coil Installation

1. Install the ignition coil and bracket to the engine bracket.
IMPORTANT: Ensure that the sealant is not applied inside the coil high tension lead tower.
2. Apply a thin bead of sealant around the outside rim of the coil high tension lead tower. Ensure that the sealant is not applied inside the coil high tension lead tower.

Tube Ref No.	Description	Where Used	Part No.
 25 	Liquid Neoprene	Outside rim of the coil wire tower	92- 25711 3

3. Connect the high tension coil lead.
4. Connect the wire harness connectors.



Spark Control Features

Idle speed spark control—The ignition module controls ignition timing to maintain a calibrated idle speed by making small spark advance adjustments. This feature is only active between 400–700 RPM.

Acceleration spark advance—When accelerating, the ignition module may add more spark advance to the Base Spark Timing Curve. The amount of spark advance added depends on how fast RPM increases. This feature is active between 1200–4000 RPM. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

Mean-best-timing (MBT) spark advance—During light load cruising, the ignition module maintains optimal ignition timing by making small spark advance adjustments. At a given RPM, the module will add a small amount of advance and wait to see if there is an RPM change. If RPM increases, it will increase timing more. The module will continue to advance timing until it no longer gets an increase in RPM. Conversely, if it senses an RPM drop, it will start to retard some of the spark timing. Between 1200–4000 RPM the ignition module can add approximately 10–15 degrees of spark advance to the base spark timing curve.

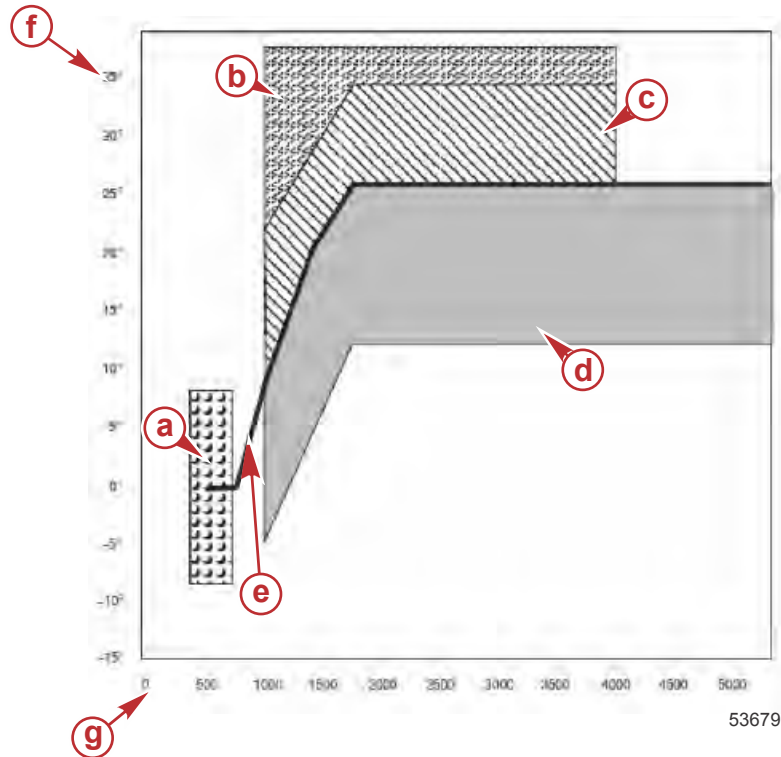
NOTE: The audio warning system is connected into the ignition module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.

Overspeed control—The ignition module will prevent the engine overspeed by adjusting the ignition spark signal. The overspeed limit is set slightly higher than the engine's recommended RPM range. Example: An operating RPM range of 4600–5000 RPM would have an overspeed limit of 5100 RPM and a reset RPM of 4750.

Knock retard spark control—The knock control module works in conjunction with the knock sensor and ignition module to retard ignition timing if knock is detected.

Thunderbolt V Spark Control Graph

IMPORTANT: The graph shows the typical advance ranges for a Thunderbolt V ignition control module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



Spark control graph

- a** - Idle speed advance range
- b** - MBT advance range
- c** - Acceleration advance range
- d** - Knock retard range
- e** - Base timing advance curve
- f** - Total spark advance minus initial timing
- g** - Engine RPM

Circuit Description

Refer to the **Ignition System Wiring Diagram** for reference to these circuit descriptions.

Ignition Control Module

- The ignition module receives power (+) through the purple wire.
- Ignition module ground (-) is accomplished through the black wire.
- There is also a case ground (-) wire that is connected to one of the ignition module mounting screws.
- The 12 volt signal from the ignition module to the distributor is carried through the white/red wire to the distributor sensor and back to the ignition module through the white/green wire.
- The tachometer signal is carried to the instrument panel through the gray wire.
- The purple/white wire carries the signal from the knock control module to the ignition control module.
- There are two black wires that have bullet connectors. This circuit is reserved for future options. On current models, the two black wires must be connected for the system to function properly.
- The tan/blue wire carries a signal from the audio warning circuit to the ignition module.

Knock Control Module

- The knock control module receives power (+) from the purple wire.
- Knock module ground (-) is accomplished through the black wire.
- The purple/white wire carries the signal from the knock control module to the ignition control module.
- The blue wire carries the signal from the knock sensor to the knock module.

Ignition Control System Timing Lead

The ignition control system has a lead with a bullet connector that is connected into the purple/white wire. When connected to an engine ground (-), this lead locks the ignition control module into the Base Timing Mode. This is used for performing the following tests and procedures:

- Setting the base ignition timing
- Setting the engine idle speed
- Setting the idle mixture
- Testing the knock control circuit

Ignition System Wiring Diagram

For 10-pin and 14-pin ignition system color wiring diagrams, refer to the **MerCruiser Color Diagram Binder**.

Ignition Module

1. Removal
 - a. Unplug the wiring harness connectors from the ignition module.
 - b. Remove the fasteners and hardware retaining the ignition module to the exhaust elbow.
 - c. Remove the module.
2. Ensure that the terminals of the wiring harness connector are clean and free of corrosion.
3. Installation
 - a. Install the ignition module using existing hardware. Tighten securely.
 - b. Plug the connectors into the ignition module.

Distributor Cap Removal

1. Loosen the distributor cap retaining screws.
2. Lift the cap away from the distributor.

Distributor Cap Cleaning and Inspection

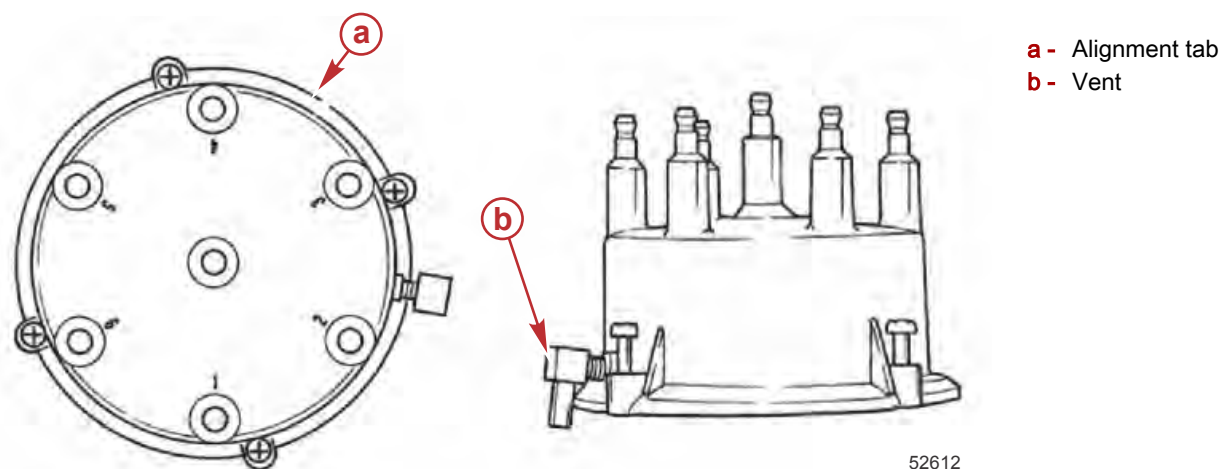
1. Check the cap contacts for excessive burning or corrosion.
2. Check the center contact for damage.
3. Check the cap for cracks or carbon tracks.
4. Clean the cap with soap and warm water. Dry it with compressed air.

Distributor Cap Installation

IMPORTANT: If the distributor cap is replaced, only use one recommended for marine applications.

NOTE: Use care when removing spark plug wires and boots from the distributor cap. Twist the plug wire boot 1/2 turn before removing it. Firmly grasp and pull on the boot to remove the wire.

1. Install the distributor cap by aligning the tab in distributor cap with the notch on the distributor body. Tighten the retaining screws.



2. For best results, individually transfer spark plug wires to the replacement cap in order of removal.

Rotor Assembly Removal

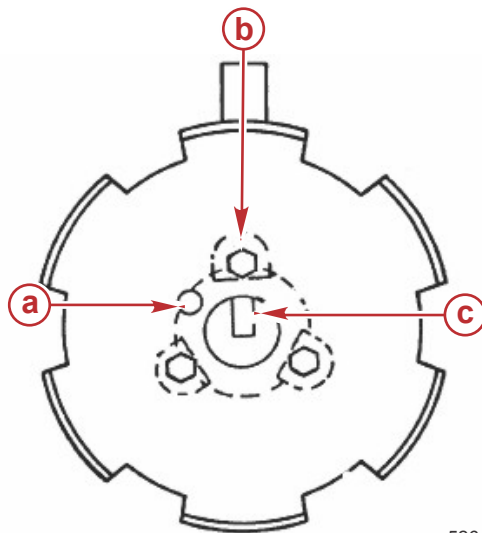
1. Position two flat blade screwdrivers opposite each other under the rotor with the blade tips contacting the distributor shaft.
2. Push down on both screwdriver handles at the same time to pry off the rotor assembly.

NOTE: The use of a torch lamp to heat the rotor assembly may aid in removal.

Torch Lamp	91-63209
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Rotor Assembly Cleaning and Inspection

1. Inspect the locating key inside the rotor for damage. The locating key should appear as a clean edged, 3 mm (1/8 in.) wide, sloped ramp at the bottom of the shaft hole.
2. Inspect the sensor alignment.
 - a. Set the sensor wheel on top of the following diagram with the sensor tangs facing up.



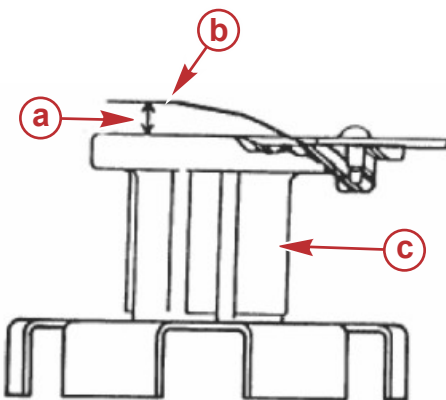
Rotor assembly sensor wheel diagram

- a** - Locating pin
- b** - Screws (3)
- c** - Locating keyway

- b. Line up the three screw holes and locating pin hole on the sensor wheel with the diagram.
 - c. If the sensor wheel is indexed properly all the sensor fingers will line up with those in the diagram.
3. Check the rotor for a burned or corroded center contact or damaged key.
4. Check the rotor for cracks and carbon tracking.

Rotor Assembly Installation

1. Ensure that the carbon brush tang has a 6 mm (1/4 in.) gap between rotor and tang.



Rotor tang clearance

- a** - Clearance measurement
- b** - Carbon brush tang
- c** - Rotor

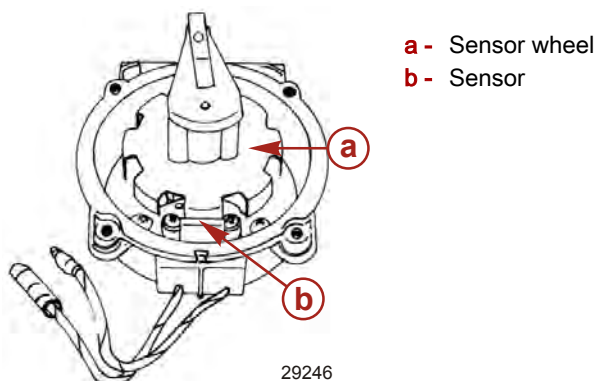
2. Put two drops of Loctite 271 Threadlocker into the rotor so it lands on the locating key.

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Key	92-809819

3. Put two drops of Loctite 271 Threadlocker in the keyway on the upper portion of the distributor shaft.
IMPORTANT: Do not let any Loctite run down the distributor shaft where it could contaminate the distributor housing bushing.

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Keyway	92-809819

4. Immediately install the rotor assembly on the distributor shaft. Ensure that the rotor locating key is aligned with the keyway in the distributor shaft. Press the rotor down on the shaft with your hand until it stops.
IMPORTANT: The rotor should fit tightly. It may be necessary to heat the rotor with a heat lamp to properly install it.
5. Let the Loctite 271 Threadlocker cure overnight with the distributor in an inverted position.



6. Install the distributor cap onto the distributor body.

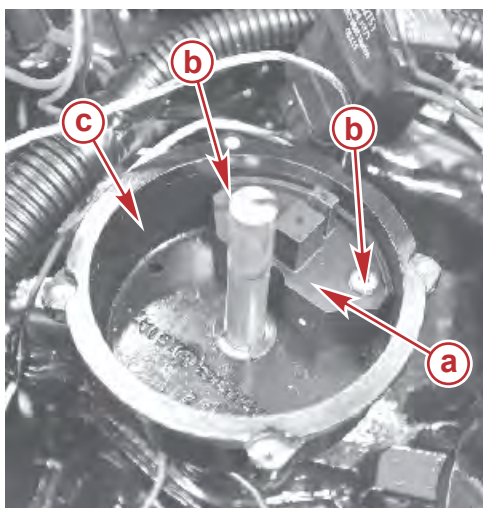
Sensor Testing

1. Disconnect the two sensor wires from the wiring harness.
2. Using an ohmmeter, check the resistance between the two sensor wires.
3. If the reading is less than 100 ohms, replace the sensor.

Description	Specification
Sensor resistance	>100 Ω

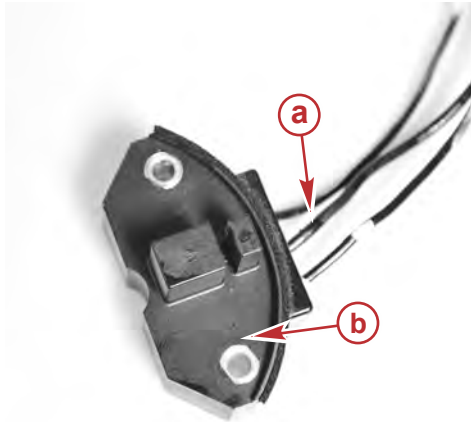
Sensor Removal and Inspection

1. Remove the rotor and sensor wheel.
2. Disconnect the sensor wires.
3. Remove the screws that hold the sensor in the distributor housing.
4. Remove the sensor from the housing.



53553

5. Use a magnifying glass and light to inspect the leads for cracks. If a crack is found in any lead, install a new sensor.

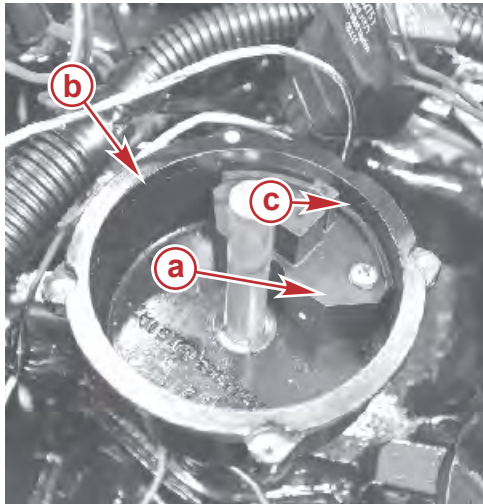


- a - Jumper leads
- b - Sensor assembly

53554

Sensor Installation

1. Install the sensor into the housing with the two retaining screws. Do not tighten them at this time.
2. Push the sensor outward until the rubber gasket is slightly compressed against the distributor housing. Then tighten the sensor mounting screws.



Distributor sensor adjustment

- a - Sensor
- b - Distributor housing
- c - Rubber gasket

53555

3. Install the sensor wheel, rotor, and distributor cap.
4. Connect the white/red and white/green sensor wires (ring terminals on engine harness wires, or bullet connectors from ignition module wires). Connect the black wire to engine ground. Tighten hex nuts securely (if equipped).

Distributor Removal

NOTE: One mounting screw protrudes through the distributor base and has a nut and washer. There is a ground lead attached to this screw.

1. Unplug the wiring harness from the ignition module. The ignition module will be mounted on the distributor housing or on the exhaust elbow, depending on the application.
2. Disconnect the sensor wires.
3. Remove the distributor cap. Do not remove the high tension leads unless necessary.
4. Crank the engine until the rotor is pointing toward the No. 1 cylinder on the distributor cap.
5. Make indexing reference marks on the distributor housing and engine block.
6. Remove the bolt and hold down clamp and remove the distributor.

IMPORTANT: Do not turn the engine while the distributor is removed.

Distributor Disassembly

1. Remove the rotor, sensor wheel, sensor, and ignition module (if it is mounted on the distributor).

2. Remove the roll pin, washer, and drive gear from the distributor shaft.
3. Check for side play between the shaft and distributor housing bushings.

Description	Specification
Distributor shaft to housing side play	0.05 mm (0.002 in.) maximum

4. Remove the shaft from the housing.
5. Check the distributor shaft runout with a dial indicator and V-blocks.

Description	Specification
Distributor shaft runout	0.05 mm (0.002 in.) maximum

Distributor Assembly

1. Lubricate the distributor shaft with SAE Engine Oil 30W.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Distributor shaft	Obtain Locally

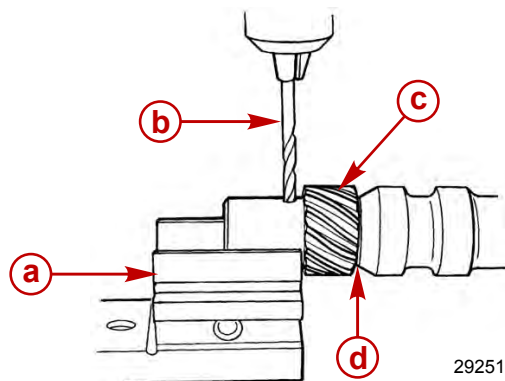
2. Install the E-clip onto the distributor shaft within the housing.
3. Install the washer onto the distributor shaft.
NOTE: The drive gear hole may be offset, allowing the drive gear to fit in only one direction.
4. Install the original drive gear. Slide it onto the distributor shaft and install the roll pin.

NOTE: A new drive gear will have a roll pin hole drilled on one side.

5. If installing a new drive gear:
 - a. Slide the drive gear onto the distributor shaft; align the hole in the gear with the hole in the distributor shaft.
 - b. Check the clearance between the drive gear and the distributor housing. The drive gear must turn freely.

Description	Specification
Distributor gear to distributor housing clearance	0.381 mm (0.015 in.)

- c. Using the hole in the drive gear and shaft as guides, drill through the other side of the drive gear with a 3/16 in. carbide tipped drill bit.



New distributor gear installation

- a - V-block
- b - 3/16 in. drill bit
- c - Drive gear
- d - Distributor gear to housing clearance

- d. Install the roll pin through the holes in the drive gear and distributor shaft.
 - e. Recheck the clearance between the drive gear and the distributor housing. The drive gear must turn freely.

Description	Specification
Drive gear to distributor housing clearance	0.381 mm (0.015 in.)

- f. If the drive gear to distributor housing clearance does not meet specification or if the drive gear does not turn freely, rotate the drive gear 90° and redrill the roll pin holes.
6. Install the sensor, sensor wheel, rotor, and ignition module onto the distributor.

Distributor Installation

1. Position cylinder No. 1 at TDC (if not already done) by either of the following methods:
IMPORTANT: Do not insert anything into a spark plug hole while turning the engine over.

Ignition System

- a. Remove the No. 1 spark plug. Attach a suitable socket and drive to the crankshaft pulley nut. Place a finger over the plug hole and turn the engine over by hand until compression is felt in the No. 1 cylinder. Continue turning the engine over by hand until the block mounted timing pointer aligns with the timing mark on the crankshaft pulley.
 - b. Attach a suitable socket and drive to the crankshaft pulley nut. Remove the left (when observed from the rear of the engine) rocker cover and turn the engine over by hand until the No. 1 cylinder intake valve is fully closed. Continue turning the engine over by hand until the block mounted timing pointer aligns with the timing mark on the crankshaft pulley.
2. Position the distributor rotor so that it would fire cylinder No. 1. Use the distributor cap as a reference.
 3. Install a new gasket on the distributor housing.
IMPORTANT: Do not use the hold down clamp and bolt to force the distributor into position.
 4. Slide the distributor into the block until it stops on its own. Do not force the distributor.
IMPORTANT: Ensure that the oil pump shaft is properly engaged. If the engine has been turned over after disassembly it may be necessary to reposition the oil pump shaft.
 5. Raise the distributor up from its initial stopping point and rotate the rotor approximately 1/8 turn counterclockwise.
 6. Continue lowering the distributor into the block, gently working the distributor and rotor so that the oil pump shaft and camshaft gear are properly engaged. It may be necessary to rotate the rotor slightly until engagement is felt.
 7. When properly installed, the distributor housing is in full contact with the machined relief in the intake manifold.
 8. Connect all ignition control wiring.
 9. Install the distributor cap and gasket. Ensure that the rotor is still pointing at the No. 1 cylinder plug wire terminal.
 10. Coat any exposed wiring and terminals with sealant.

Tube Ref No.	Description	Where Used	Part No.
 25 	Liquid Neoprene	Electrical terminals	92- 25711 3

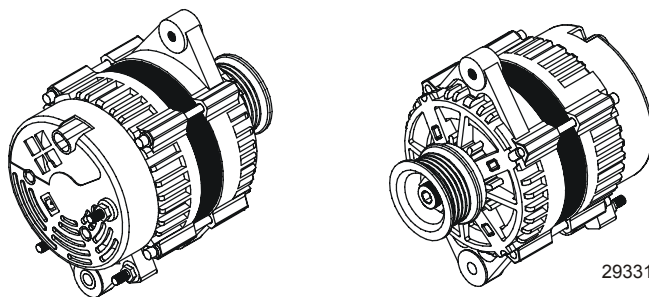
Electrical System

Section 4C - Charging System

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Pulley—Sterndrive Models.....	4C-4	Battery Isolator Diagrams.....	4C-9

Specifications



Typical Delco Alternator

Description	Specification
Excitation circuit	1.3 to 2.5 V
Current output	60 amp minimum
Voltage output	13.9 to 14.7 V
Minimum brush length	6 mm (1/4 in.)

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

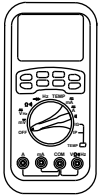
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

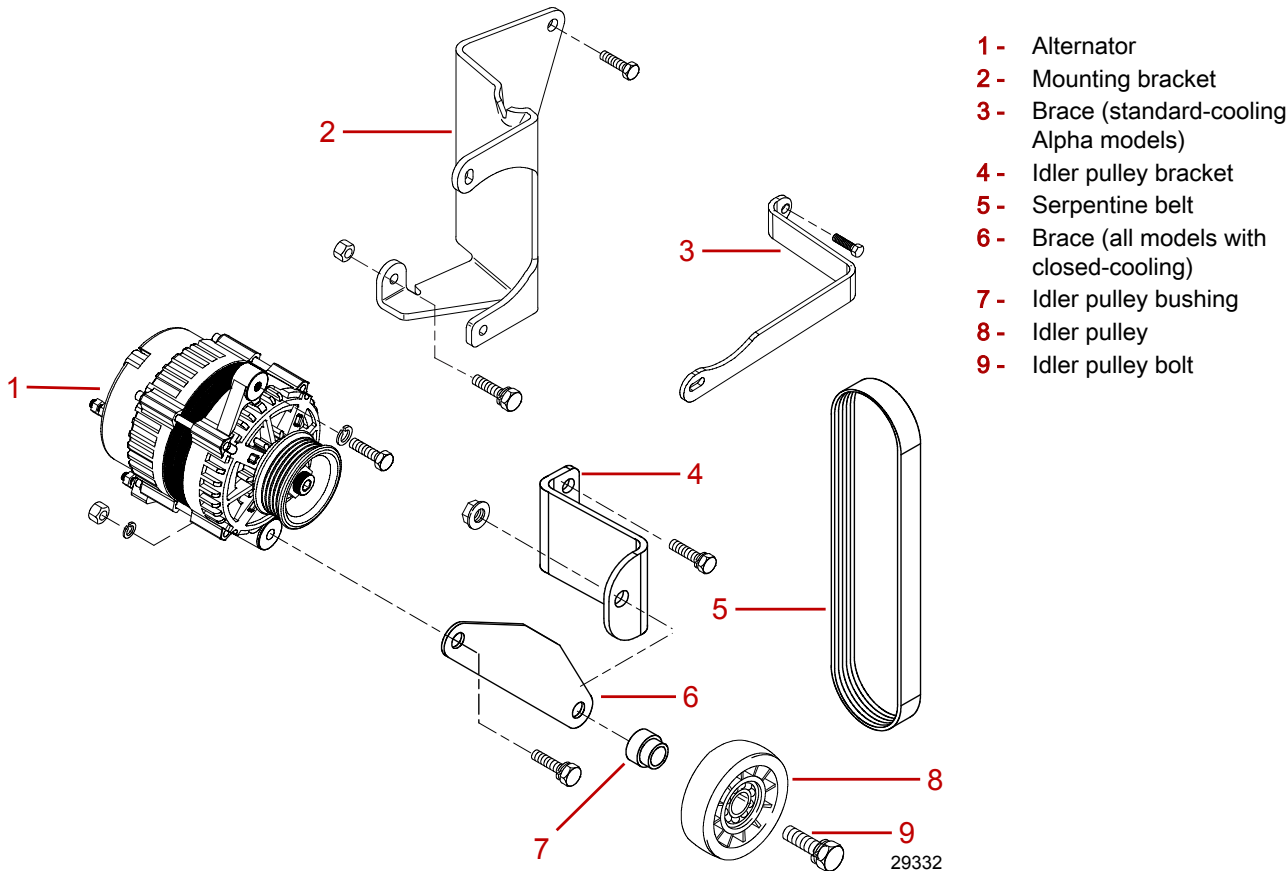
- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Special Tools

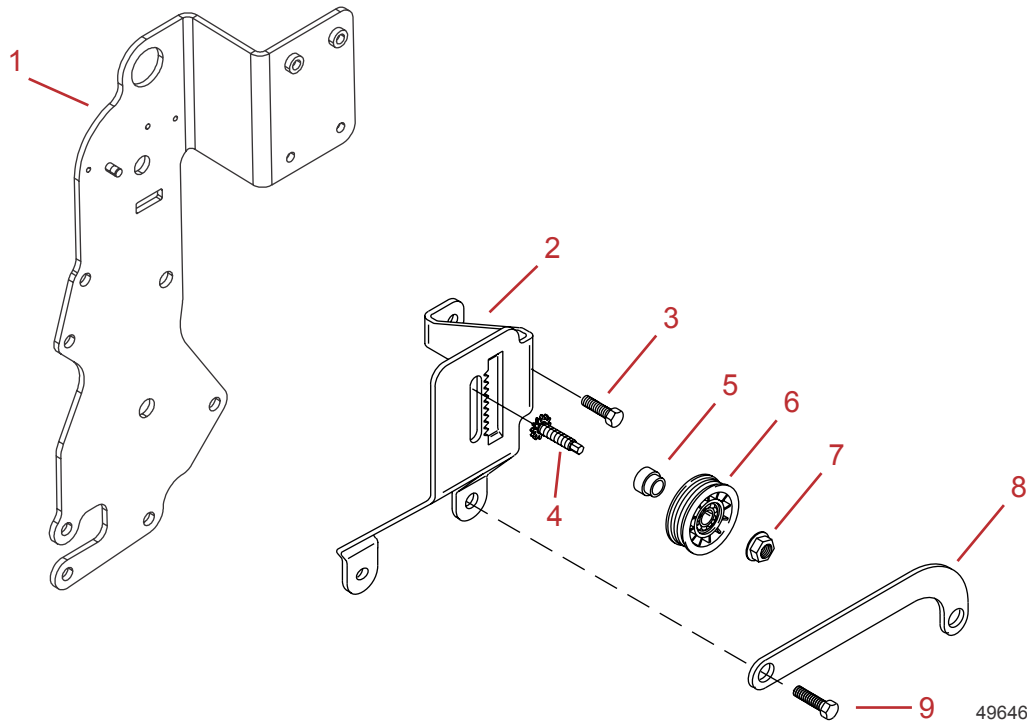
DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Exploded Views

Alternator Exploded View—Sterndrive Models



Alternator-Related Brackets and Idler Adjustment Pulley—Sterndrive Models



- 1 - Bracket
- 2 - Bracket, idler adjustment
- 3 - Screw
- 4 - Pinion stud
- 5 - Bushing
- 6 - Pulley
- 7 - Nut
- 8 - Brace, power steering
- 9 - Screw

Periodic Maintenance

IMPORTANT: Observe all recommended service intervals outlined in the owner's manual provided with each specific product package.

1. Inspect the entire charging system for loose, damaged, or corroded connectors.
2. Inspect the charging system wiring for damaged insulation.
3. Check the alternator drive belt tension and drive belt tensioner for proper operation.
4. Inspect the alternator drive belt for excess wear and damage.
5. Check all alternator mounting hardware for proper torque.

Troubleshooting

Troubleshooting Tests (Alternator on the Engine)

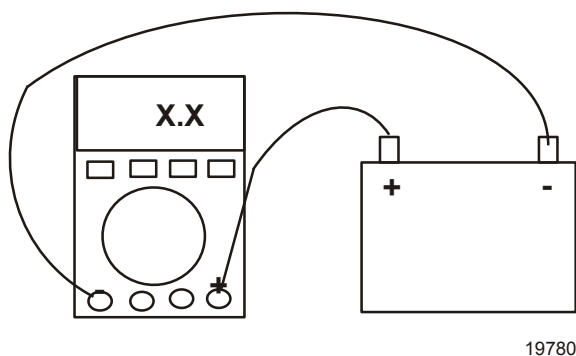
Use the following tests in conjunction with **Section 1 - Troubleshooting**. Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe **Precautions**, preceding, to prevent damage to the alternator system.

1. Excessive current draw from accessories or by operating the engine at low speeds for extended periods may deplete the battery charge.
2. Check the physical condition and charge of the battery. The battery state-of-charge must be at least 75% (1.230 specific gravity) to obtain valid results in the following tests. If the battery does not meet the minimum specifications, charge the battery before testing the charging system.
3. Inspect the entire charging system wiring for defects. Ensure that all connections are secure and clean.
4. Check the drive belt for excessive wear, cracks, fraying, and glazed surfaces. Replace if necessary.

5. Check the drive belt tension and adjust if necessary.

Charging System

1. With a fully charged battery, connect the voltmeter leads directly to the battery posts.



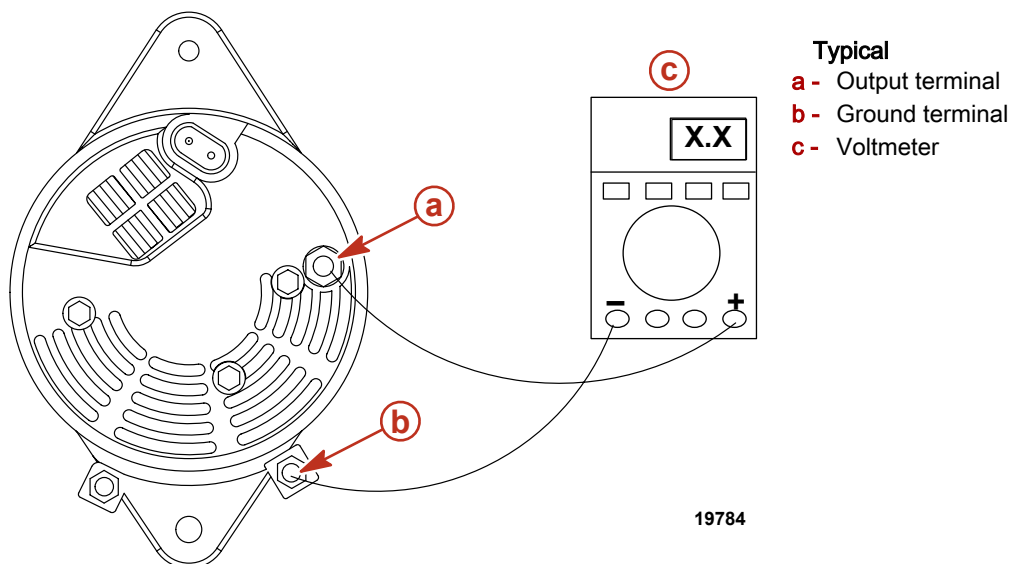
DMT 2004 Digital Multimeter

91-892647A01

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

2. Supply cooling water to the engine.
3. Start the engine and run at 1300–1500 RPM. Read the voltmeter in VDC position. Most systems will read 13.8–14.8 volts.
NOTE: If the voltage reading is within specifications, switch the voltmeter to the AC volt position. There must not be more than a 0.250 AC voltage reading with the engine running. A reading of more than 0.250 AC volts indicate defective diodes in the alternator.
4. If the voltmeter reading at the battery posts is below 13.5 volts, connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the ground terminal on the alternator.

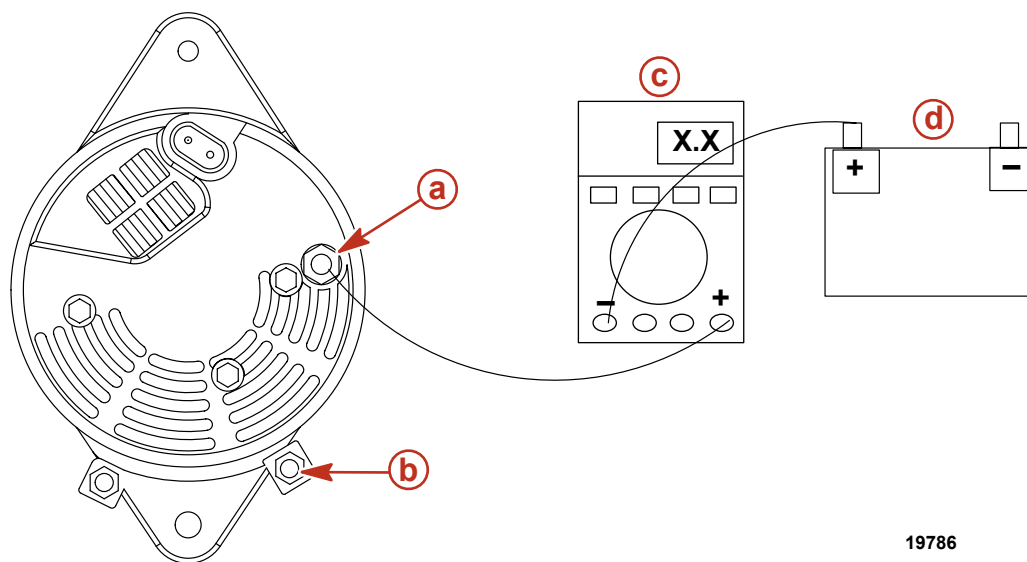


5. If the voltmeter reading is now within specifications, too much resistance exists between the alternator and the battery.
6. If the reading is below 12.5 volts, the alternator may not be charging. Check all of the wiring leading to the alternator.

Charging System Resistance

1. Pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD."
2. Crank the engine over for 15 seconds to discharge the battery slightly.
3. Reset the lanyard stop switch (if equipped), or enable the ignition circuit by installing the fuse marked "CD," and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal (orange wire). Connect the voltmeter negative (–) lead to the battery positive (+) post.

NOTE: Connect the voltmeter leads to the battery post, not the battery cable end.

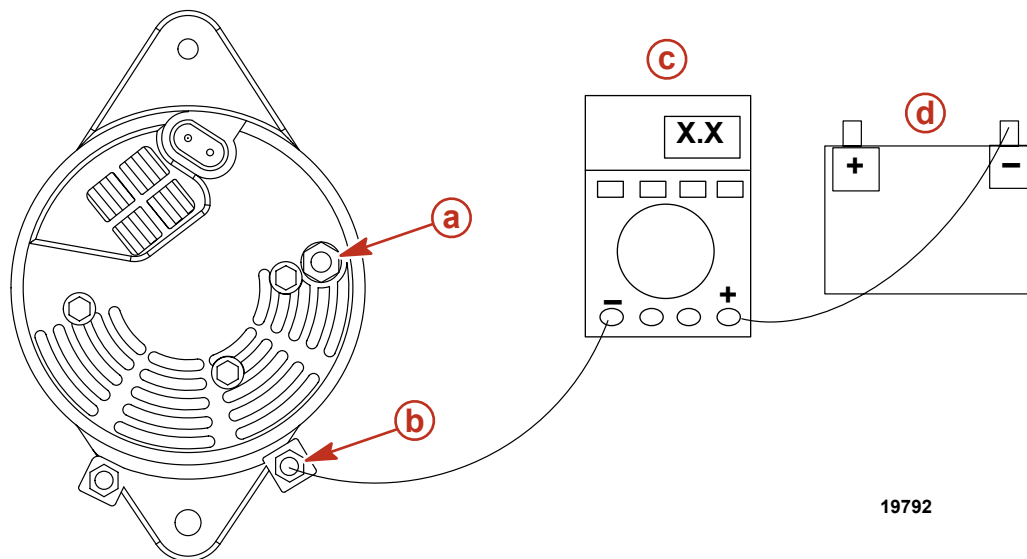


Typical

- a** - Output terminal
- b** - Ground terminal
- c** - Voltmeter
- d** - Battery

DMT 2004 Digital Multimeter	91-892647A01
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5. Start the engine and run at 1300–1500 RPM. Read the voltmeter. A reading of more than 0.5 volts shows excessive resistance in the wiring.
6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect the voltmeter positive (+) lead to the battery negative (–) post.



Typical

- a** - Output terminal
- b** - Ground terminal
- c** - Voltmeter
- d** - Battery

7. Repeat step 5.

Circuitry

Perform the following tests, using a 0–20 volt DC voltmeter, to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

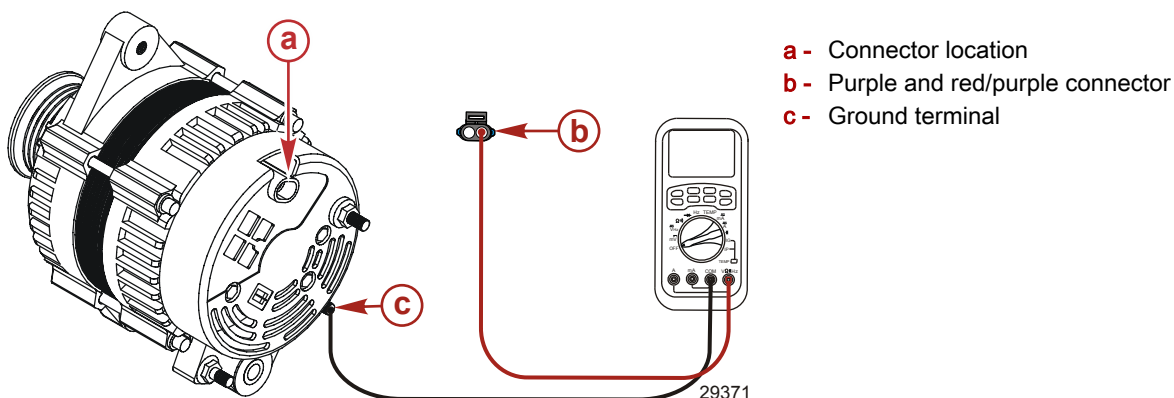
DMT 2004 Digital Multimeter	91-892647A01
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Sensing and Excitation Circuits

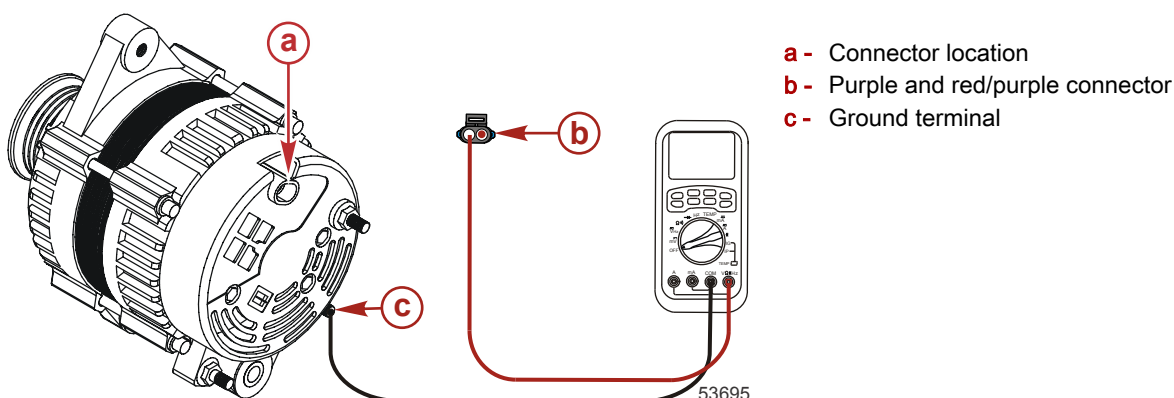
1. Unplug the purple and red/purple connector from the alternator.
2. Connect the positive (+) voltmeter lead to the red/purple lead and negative (–) voltmeter lead to the ground terminal.

DMT 2004 Digital Multimeter	91-892647A01
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3. The voltmeter should indicate battery voltage. If battery voltage is not present, check the circuit breaker and battery power interface for loose or dirty connection or damaged wiring.



4. Connect the positive (+) voltmeter lead to the purple lead and negative (–) voltmeter lead to the ground terminal.
5. Turn the ignition switch to the "ON" position.
6. The voltmeter should indicate battery voltage. If battery voltage is not present, check the ignition circuit (purple lead) for loose or dirty connection or damaged wiring.

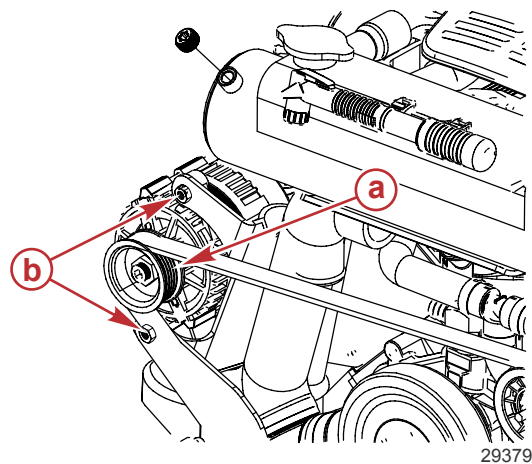


Alternator Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect both battery cables from the battery, being certain to disconnect the negative (–) cable first.
2. Disconnect the alternator lead and ground wires.
3. Disconnect the alternator excitation wire.
4. Remove the drive belt.
5. Remove the alternator mounting bolts and washers.



Sterndrive alternator
a - Alternator
b - Bolts and washers (2)

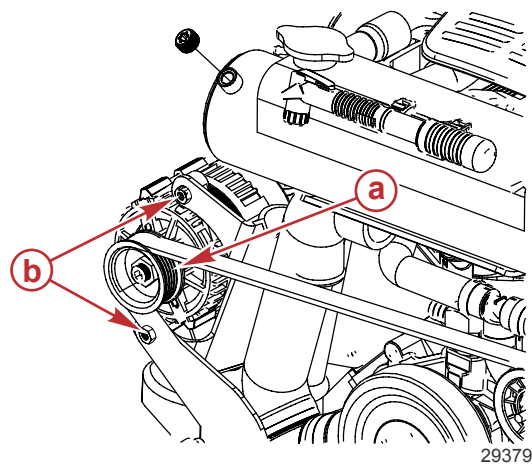
6. Remove the alternator.

Alternator Installation

1. If the alternator bracket has been removed:
a. Install the alternator bracket. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Alternator bracket screws	41	–	30

- b. Install the water circulating pump hose and securely tighten the hose clamps.
2. Install the idler brace, if it was removed.
3. Position the alternator in the mounting bracket.



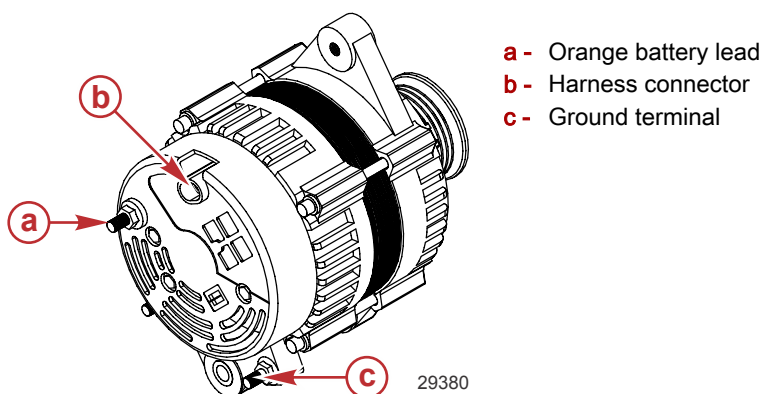
Sterndrive alternator
a - Alternator
b - Bolts (2)

4. Install the mounting bolts and tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Alternator mounting bolts	11	97	–

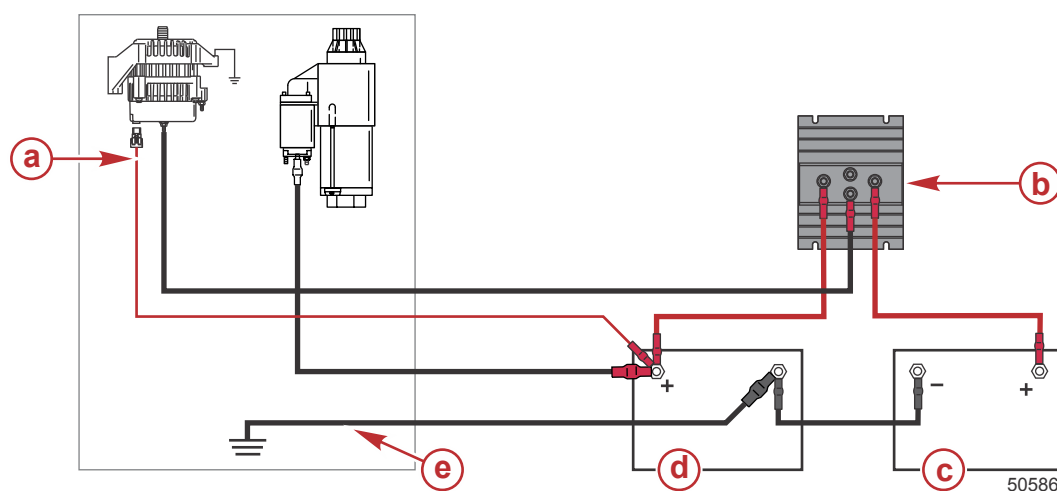
5. Install the drive belt and adjust the tension. Refer to **Serpentine Drive Belt** in **Section 1C - Maintenance**, for the detailed tensioning procedure.

6. Reconnect the alternator wiring.



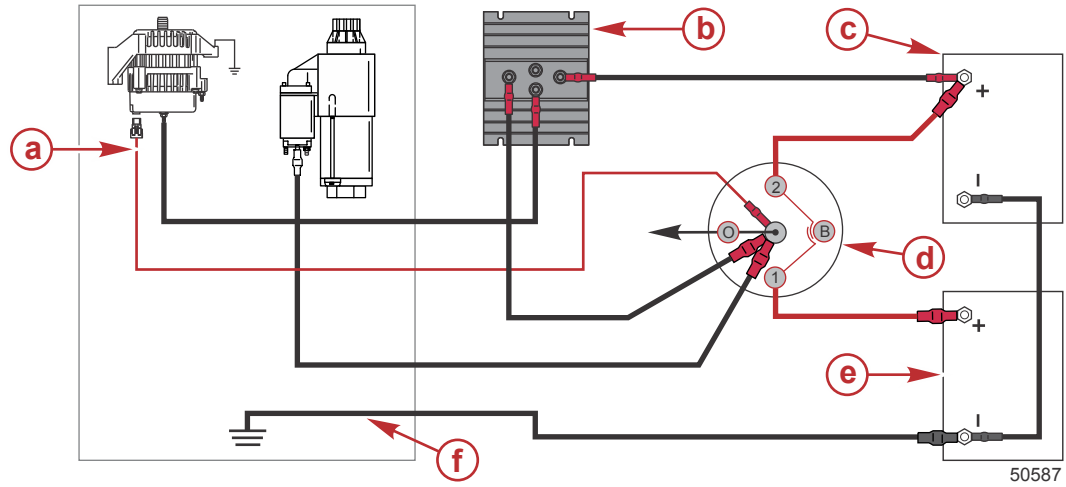
7. Reconnect both battery cables, being certain to connect the negative (–) cable last.
8. Fill the cooling system with the specified fluid. Refer to **Section 1C - Maintenance**.

Battery Isolator Diagrams



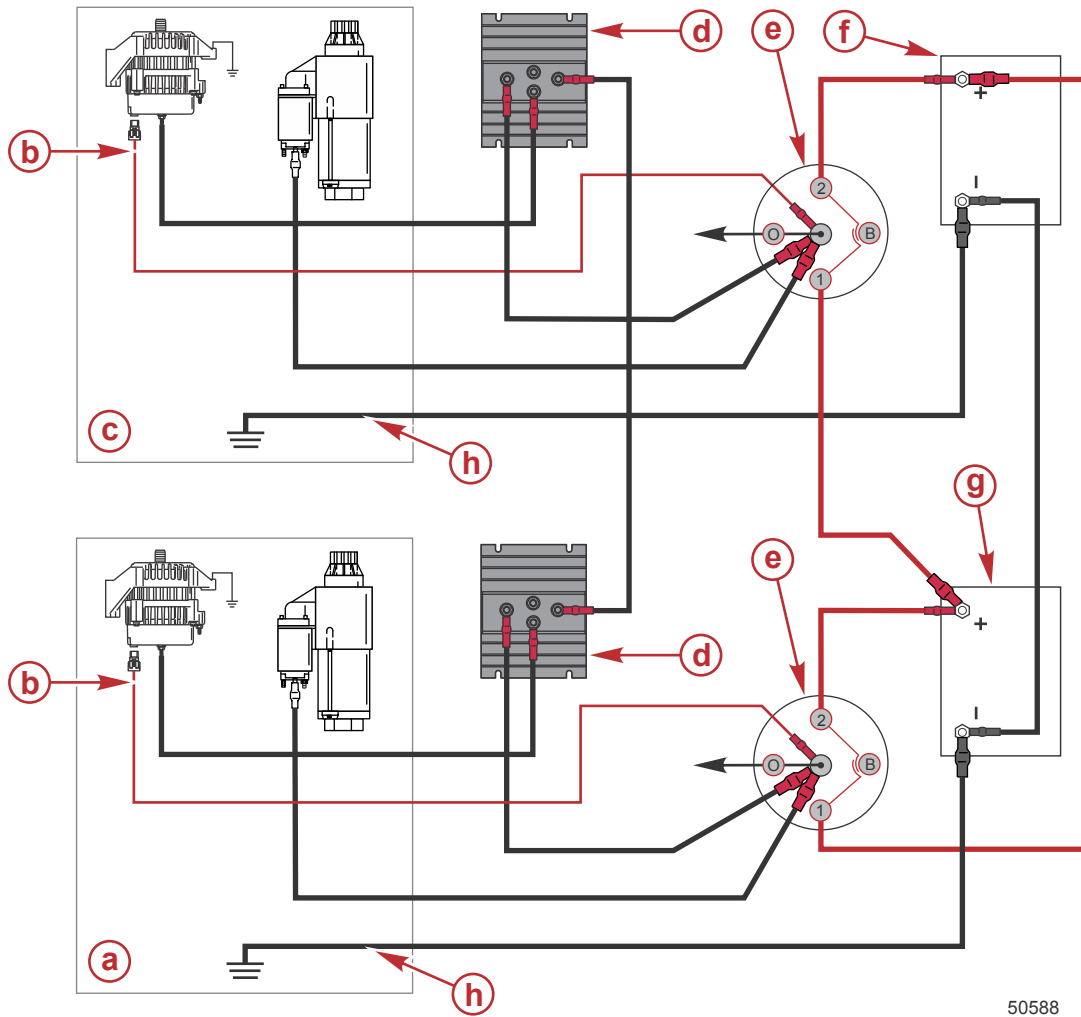
Typical single-engine battery isolator wiring

- a - Alternator sense wire
b - Battery isolator
c - Auxiliary battery
d - Cranking battery
e - Engine ground



Typical battery isolator with disconnect switch

- a** - Alternator sense wire
- b** - Battery isolator
- c** - Auxiliary battery
- d** - Battery disconnect switch
- e** - Cranking battery
- f** - Engine ground



50588

Typical dual-engine application

- a** - Starboard engine
- b** - Alternator sense wire
- c** - Port engine
- d** - Battery isolator
- e** - Battery disconnect switch
- f** - Port engine cranking battery
- g** - Starboard engine cranking battery
- h** - Engine ground

Notes:

Electrical System

Section 4D - Instrumentation

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Lubricant, Sealant, Adhesives

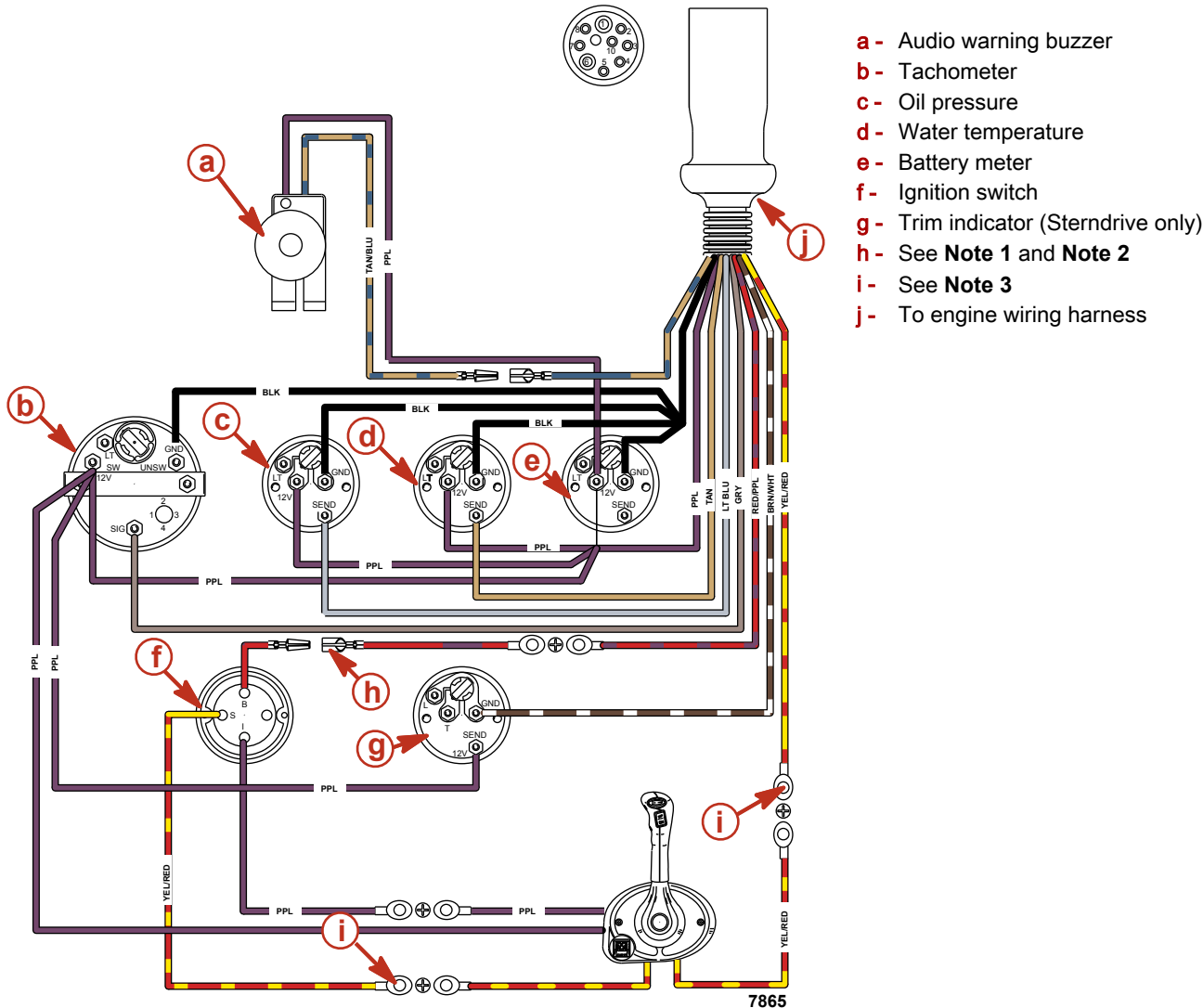
Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Electrical terminals and connections	92- 25711 3

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

10-Pin Helm Harness

Instrument Harness



Refer to gauge manufacturer's instructions for specific connections.

- **Note 1:** Connect wires together with screw and hex nut; apply liquid neoprene to connection and slide rubber sleeve over connection.
- **Note 2:** Power for a fused accessory panel may be taken from this connection. load must not exceed 40 amps. panel ground wire must be connected to instrument terminal that has an 8-gauge black (ground) harness wire connected to it.
- **Note 3:** Lanyard stop switch lead and neutral safety switch leads must be soldered and covered with shrink tube for a water proof connection. if an alternate method of connection is made, verify connection is secure and sealed for a water proof connection.

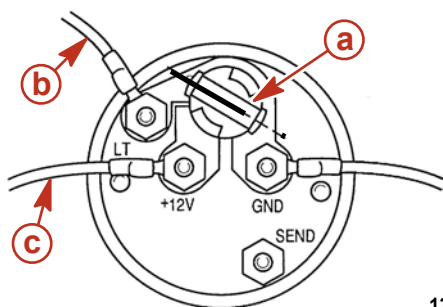
Analog Instrumentation

Gauge Lighting Options

Some gauges (Admiral and Flagship series) are equipped with two bulb socket settings for optional lighting configurations. The light bulb socket can be removed and the contacts can be aligned to be used with an ignition switch lighting circuit (+12 V) or a separate instrumentation lighting circuit (LT).

The standard position is instrumentation lighting circuit (LT) for use with the separate panel lights and audio test switch.

IMPORTANT: To adjust the lighting option to the desired setting, you must remove the light socket from the gauge and then turn it. Turning the socket while it is installed in the gauge could result in damage to the gauge or socket.



- a - Light socket
- b - +12 V power supply from the panel lights and audio test switch
- c - +12 V power supply from the ignition switch

Removal

1. Disconnect the battery cables. Remove the negative (–) cable first.
2. Remove the wires from the back of the gauge.
3. Disconnect the light socket wiring, if separate.
4. Remove the holding strap or unscrew the mounting ring around the gauge, and remove the gauge.

Installation

1. Position the gauge assembly in the appropriate mounting hole.
IMPORTANT: Do not distort the case or bracket by overtightening.
2. On models with a holding strap: install the holding strap and nuts. Tighten the nuts evenly and securely.
3. On models with a mounting ring: install the mounting ring. Tighten the mounting ring securely. Do not overtighten.
4. Connect the other wires to the gauge as appropriate.
5. Install the gauge light socket.
6. Coat all exposed terminals with liquid neoprene.

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Electrical terminals and connections	92- 25711 3

7. Reconnect the battery cables to the battery.

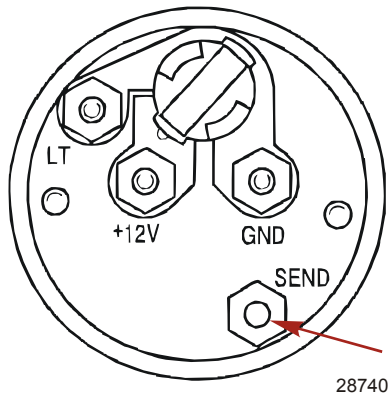
Analog Gauge Testing

Oil Pressure, Fuel Level, and Coolant Temperature Gauges

IMPORTANT: A defective gauge must be replaced. Repair is not available.

1. Turn the ignition switch (key switch) to the "OFF" or "0" position, whichever applies to the switch.

2. Remove the signal wire from terminal SEND ("S") or "G" (gauge), whichever applies to the gauge.



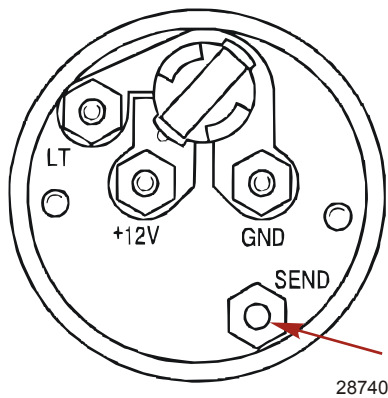
SEND ("S") terminal

3. Turn the ignition switch to the "RUN" or "1" position, whichever applies to the key switch style. The needle of the gauge must be in the indicated position.



Typical gauge

4. Turn the ignition switch to the "OFF" or "0" position, whichever applies to the key switch.
5. **On Flagship and Admiral gauges:** Connect a jumper wire from terminal G (GND) to terminal SEND ("S").



SEND ("S") terminal

6. **On VDO gauges:** Connect a jumper wire from terminal "-" (negative, or ground) to terminal "G" (gauge).

- Turn the key switch to the "RUN" or "1" position, whichever applies to the key switch. The needle of the gauge must be in the indicated position.



Typical gauge

- If the gauge does not respond as indicated it is defective and must be replaced.

Battery or Voltage Gauge

In-the-Boat Testing

- Connect a digital multimeter (DMM) to the terminals on the back of the gauge.
- Set the DMM to VDC.
- Turn the key switch to the "ON" or "RUN" position.
- The voltage indicated by the gauge should match the voltage measured by the DMM. If the values do not match, replace the gauge.

Bench Testing

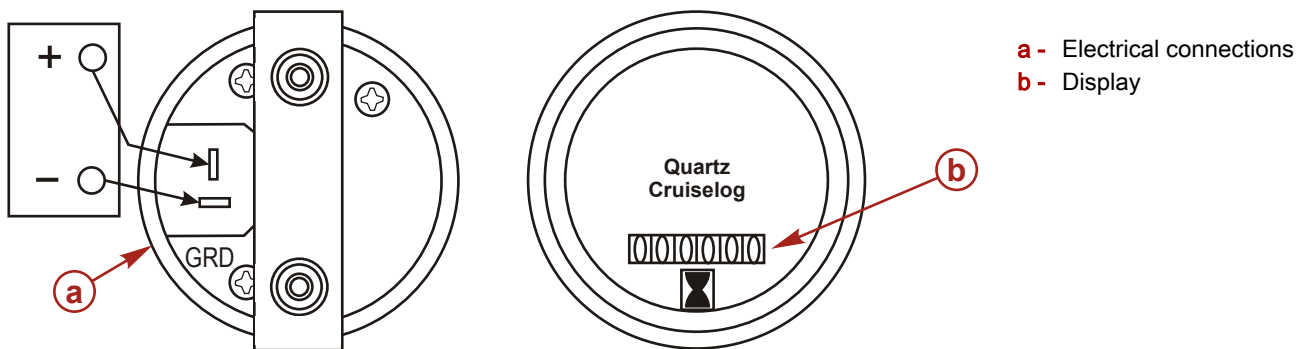
If the gauge is disconnected from the boat's wiring, the gauge may be checked with any known good voltage source that is at least 9 VDC but no greater than 15 VDC.

IMPORTANT: Connecting the gauge with the incorrect polarity could damage the gauge.

- Connect the gauge's negative (–) terminal to the negative (–) terminal of the known good voltage source.
- Connect the gauge's positive (+) terminal to the positive (+) terminal of the known good voltage source.
- Check the position of the gauge needle. If it does not indicate the voltage of the source, replace the gauge.

Cruise-log (Engine Hour Meter)

- Remove the battery cables and fully charge the battery.
- Remove the wires from the rear of the gauge.
- Connect a positive (+) jumper lead from the battery to gauge terminal + (12 V).



6487

- Connect a negative (–) jumper lead from the battery to gauge terminal "GND" (ground) or "–" (negative, or ground).
- If the indicator display is not turning, the gauge is operable. Replace the gauge.

Tachometer

- Connect a service tachometer to the engine and compare readings between the service tachometer and the helm tachometer.
- If the gauge is not accurate, make sure that the switch on the rear of the tachometer is set properly. Refer to the manufacturer's instructions that accompanied the gauge for an explanation of selections.
- If the gauge does not meet the specifications, replace the gauge.

Tachometer Type	Allowable Range
5000 RPM maximum	± 100 RPM
6000 RPM maximum	± 150 RPM

Speedometer

IMPORTANT: When testing the speedometer for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure.

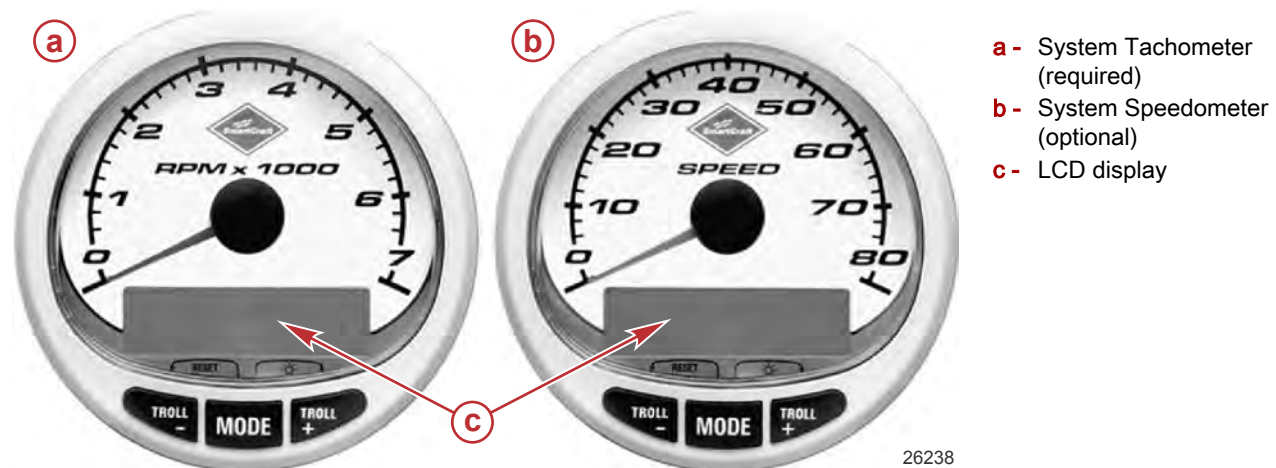
1. Supply the specified air pressure to the speedometer gauge pitot tube and compare the gauge readings to the specification. Lightly tap the pressure gauge during the accuracy check.
2. If the gauge readings are not within specifications, replace the gauge.

Air pressure	Speedometer display
36.5 kPa (5.3 psi)	32 km/h ± 1.6 km/h (20 mph ± 1 mph)
192 kPa (27.8 psi)	72 km/h ± 1.6 km/h (45 mph ± 1 mph)

SmartCraft Instrumentation

Basic Operation

Refer to the instructions included with each Mercury SmartCraft instrument for complete calibration and installation information. Refer to the **Mercury Precision Parts Accessories Guide** for additional SmartCraft options.



- **Power up:** Gauges receive power when the ignition is turned on.
- **Lights:** The brightness and contrast are adjustable.
- **Buttons:** The "MODE" button is used for selecting information screens. The "+" and "-" buttons are for user input and setting gauge calibrations.
- **Troll control:** Allows the operator to set and control the idle speed of the engine for trolling without using the throttle.
- **Engine Guardian system:** Monitors the critical sensors on the engine for early indications of problems. The system will respond to a problem by reducing engine speed in order to maintain a safe operating condition.
- **Warning system:** The system will sound the warning horn and display the warning message.
- **Digital display screen:** Displays the following engine information (depending on engine type):

SC1000 System Tachometer display screen

- Engine RPM
- Engine temperature
- Engine oil pressure
- Trim and RPM
- Trim and water pressure
- Water pressure
- Battery voltage and engine hours

SC1000 System Speedometer display screen

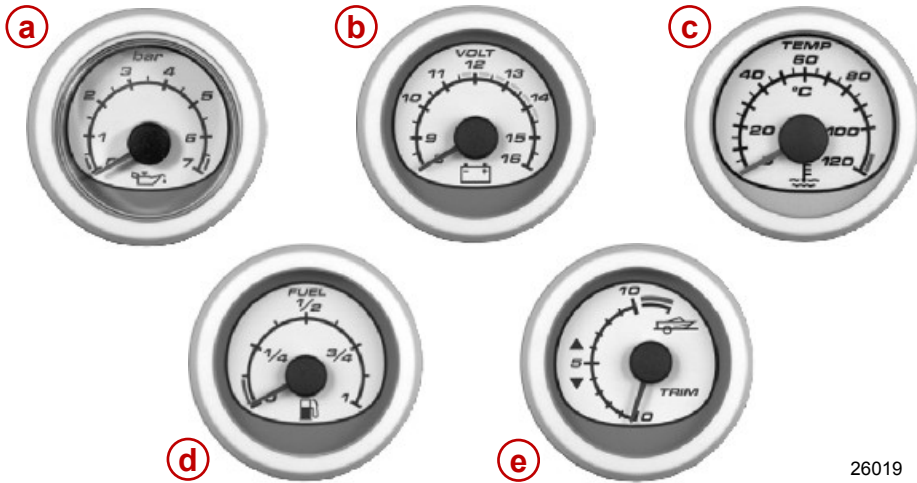
- Speed
- Trim and RPM synchronizer
- Trip odometer
- Fuel range
- Fuel economy
- Instant and average fuel economy
- Fuel used

SC1000 System Tachometer display screen

- Fuel flow and fuel used
- Depth
- Engine break-in

SC1000 System Speedometer display screen

- Fuel tank levels
- Oil tank levels
- Fresh water tank level
- Waste water tank level
- Clock and air/sea temperature
- Distance and fuel to waypoint, if a waypoint is programmed into the optional GPS
- Optional GPS input display

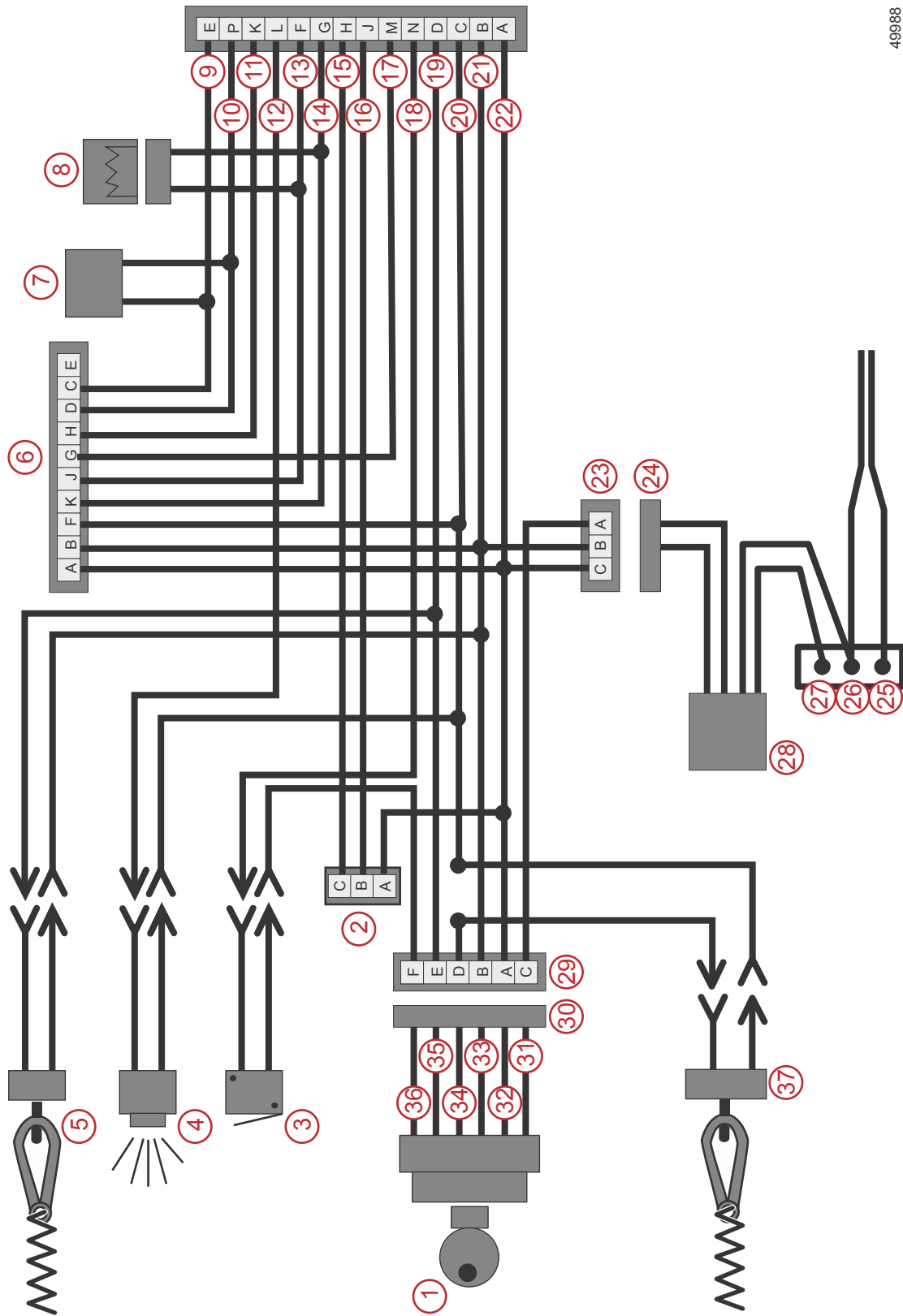
**Optional System Link (gauges typical)**

- a** - Oil pressure
- b** - Battery voltage
- c** - Water temperature
- d** - Fuel level
- e** - Trim

26019

System Link digital gauges are connected in series and receive their data from the System Tachometer.

Non-DTS Single-Station Instrumentation Installation



49988

Typical non-DTS 14-pin boat harness, single station

- 1 - Key switch
- 2 - Not used on MerCruiser products
- 3 - Neutral start switch
- 4 - Audio warning alarm
- 5 - Alternate lanyard E-stop (MPI only)
- 6 - Gauge connector (analog gauges) or SmartCraft digital gauges
- 7 - CAN V line
- 8 - CAN P resistor
- 9 - Oil pressure (CAN V +)
- 10 - Water temperature (CAN V -)
- 11 - Trim position (CAN X +)
- 12 - Horn (CAN X -)
- 13 - CAN P +
- 14 - CAN P -
- 15 - Spare
- 16 - Spare
- 17 - Tachometer
- 18 - Start
- 19 - E-stop (MPI only)
- 20 - Wake
- 21 - Ground (-)
- 22 - 12 volts
- 23 - 3-pin metri pack (female) for optional accessory wiring kit
- 24 - 3-pin metri pack (male) for optional accessory wiring kit
- 25 - Ground (-)
- 26 - 12 volts (continuous)
- 27 - 12 volts (switched)
- 28 - Relay
- 29 - Key switch 6-pin connector (female)
- 30 - Key switch harness
- 31 - Accessory power
- 32 - 12 volts
- 33 - Ground (-)
- 34 - Run
- 35 - Emergency stop
- 36 - Start
- 37 - Typical lanyard stop

SmartCraft Connections

SmartCraft Compatibility

IMPORTANT: Digital gauges are available for use on Mercury MerCruiser engines equipped with the ECM 555 or later model controllers.

All System Series instruments are compatible with MerCruiser products.

- SC1000 System monitor
- SC1000 System Tach and Speed
- SC100 System Link gauges

SmartCraft System Rules

Controller area network (CAN) data bus wiring rules are the same for all SmartCraft compatible products.

- There are two termination resistors per CAN.
- Termination resistors define the ends of the CAN bus trunk.
- The maximum allowable CAN bus trunk cable length is 36.6 m (120 ft).
- Drops from the trunk should not exceed 1.8 m (6 ft).
- The maximum allowable distance between any two modules is 40.2 m (132 ft) (36.6 m [120 ft] trunk plus 1.8 m [6 ft] on each end).

- The CAN bus will support a maximum of 20 devices.

On dual engine applications, instrument harness part number 84-892323Txx (or equivalent for triples and quads) allows activation of all gauges from any key switch.

When installing a blue CAN data or System Tach/Speed harness, the end of the harness with multiple connectors must be connected to the SC1000 gauge. The System Link signals come from the SC1000 gauge. If the harness is reversed, there is no path for the System Link signals to transfer from the SC1000 gauge to the System Link gauges.

CAN Bus Overview

The wires required for three CAN (controller area network) buses can be found within the 14-pin harness that connects the engine to the helm. These buses carry communications between the various controllers used by the engines and helms. Each CAN bus consists of a twisted pair of wires—twisting the pair helps prevent electrical interference. If either wire develops an open or short, that CAN bus will stop communicating.

The three buses integral to the 14-pin harness are known as CAN P, CAN X, and CAN V. Boats equipped with 360° control systems (such as Axis) use a portion of the CAN V bus to implement a separate bus, known as CAN H. Boat control systems cannot simultaneously implement CAN V and CAN H.

NOTE: CANs P, X, and V were originally known as CANs 1, 2, and 3, respectively.

1. The CAN P (propulsion) circuit (blue and white wires) connects together the engine modules, helm modules, and SmartCraft gauges and displays. Its primary purpose is to provide a path for data (such as temperatures, pressures, depth, boat speed, tank levels, and engine speed) to the SmartCraft gauges and displays. It is also used by diagnostic tools that cannot communicate on CAN X. Finally, CAN P provides a redundant set of throttle and shift commands; should CAN X fail, the operator will still be able to control the boat at reduced power. There is one CAN P bus per boat, regardless of the number of engines or helms.
2. The CAN X (throttle and shift control) circuits (yellow and brown wires) connect one engine to its Digital Throttle and Shift (DTS) command modules. No tools, gauges, or displays may be connected to a CAN X bus. Each engine will have its own CAN X bus.
3. The CAN V (vessel) circuit (orange and green wires) is used to transmit SmartCraft network compliant vessel accessory and equipment data to the helm station. Examples of items found on a CAN V bus are generator sets, bilge pumps, blowers, and interior lights. The CAN V wires in the 14-pin harness are often used for alternate purposes when CAN V functionality is not required.
4. The CAN H (high-speed helm) circuit is unique to 360° control systems, such as Axis. There is one CAN H bus per boat. It provides a high-speed path for the starboard and port helm modules to communicate with each other when they are jointly determining the proper steering, shift, and throttle commands. Once determined, the shift, throttle, and steering commands are transmitted through each engine's CAN X bus. The CDS G3 tool is the only tool certified to communicate on CAN H.

Termination Resistors

Termination resistors are CAN line signal conditioners. The resistor places a known load on the CAN line to ensure proper system communication. All CAN bus termination resistors are 120 ohms. Each CAN bus has two termination resistors installed, one at each of the furthest ends of the bus' running length. With all modules and gauges disconnected from the bus, the resistance between the two data communication wires of the CAN bus should be approximately 60 ohms. Incorrect CAN bus termination, usually caused by too few or too many installed termination resistors, will result in communication errors or complete failure of that CAN bus.



Yellow 10-pin termination resistor

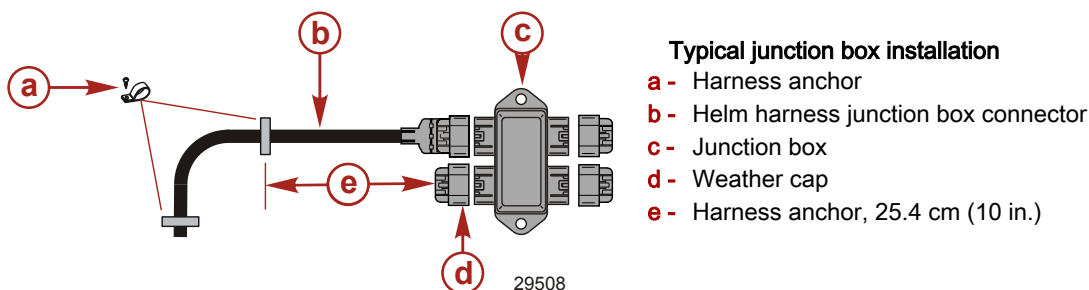


Blue 2-pin termination resistor

Junction Box Installation (If Equipped)

1. Follow all wiring harness installation specifications and guidelines.
2. Confirm that all applicable wiring reaches the mounting location.
3. Mount the junction box in a location that minimizes exposure to moisture.
4. Mount the junction box so the connectors run horizontally.
5. Mount the junction box in a location that is accessible for service.
6. Securely attach the junction box using the screw holes provided and fasteners appropriate to the boats construction.

7. Anchor all wiring harnesses within 25.4 cm (10 in.) of the junction box connectors.
8. Protect all unused connectors with weather caps.



Connecting SmartCraft Components

Install all SmartCraft equipment and accessories according to the instructions provided with each component.

Due to the variety of SmartCraft configurations, this manual cannot describe installation procedures for all configuration possibilities. Follow these general guidelines:

- Use two termination resistors in the system. You can order harnesses with or without in-line resistors.
- If using a component harness with an in-line resistor, do not use a termination resistor at that end of the helm harness.
- If using junction boxes, place one box (4, 6, or 8 port as needed) at the helm for each engine.
- If making only one 10-pin SmartCraft connection at the helm, use a 10-pin female-to-female adapter in place of a junction box.
- Position the CAN P termination resistors at opposite ends of the CAN bus:
 - For single-engine applications, use termination resistors at the engine and at the furthest helm.
 - For dual-engine applications, use termination resistors at both engines.
 - For triple-engine applications, use termination resistors at the starboard outer engine and at the furthest helm.
 - For quad-engine applications, use termination resistors at the starboard outer engine and the port outer engine.
- We recommend leaving at least one port free on each junction box for diagnostic work and future system modifications. Protect unused junction box ports with weather caps.
- System Tachometer and Speedometer harness connectors are labeled. If a connector labels become unreadable, identify the connectors by their relative location on the harness:
 - The System Tachometer (used for the System Monitor as well) gauge connector is located on the end of the harness that includes the 3-pin link gauge connector.
 - The System Speedometer gauge connector is located on the end of the harness that includes the two wire NMEA connections.

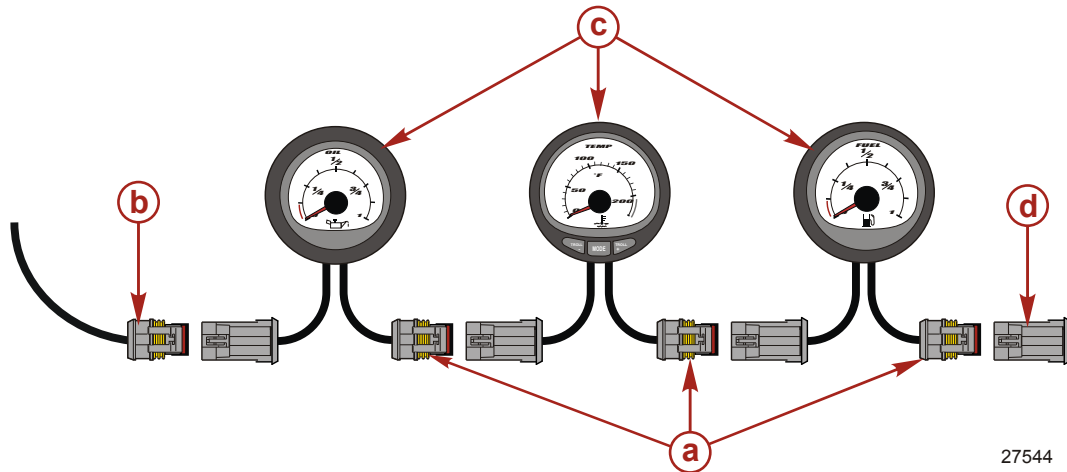
IMPORTANT: The female 10-pin connectors on the System Tachometer and Speedometer harnesses are not interchangeable. Install the System Tachometer and Speedometer with the correct harness for the type of gauge used.

- Configure each System Tachometer, System Monitor, and VesselView instrument with its unique engine and helm station identity when setting up the gauge.

NOTE: Refer to the *Mercury Precision Parts and Accessories Guide* or the *SmartCraft Product Guide* for help with ordering the appropriate SmartCraft equipment.

System Link Gauge Connections

System Link gauges receive their data signal from a System gauge (System Monitor, System Tachometer, or VesselView) or from a System Link adapter harness. This enables the use of System Link gauges in a variety of situations and configurations. System Link gauges connect in series. Protect the System Link connector of the final gauge in a series with a weather cap.



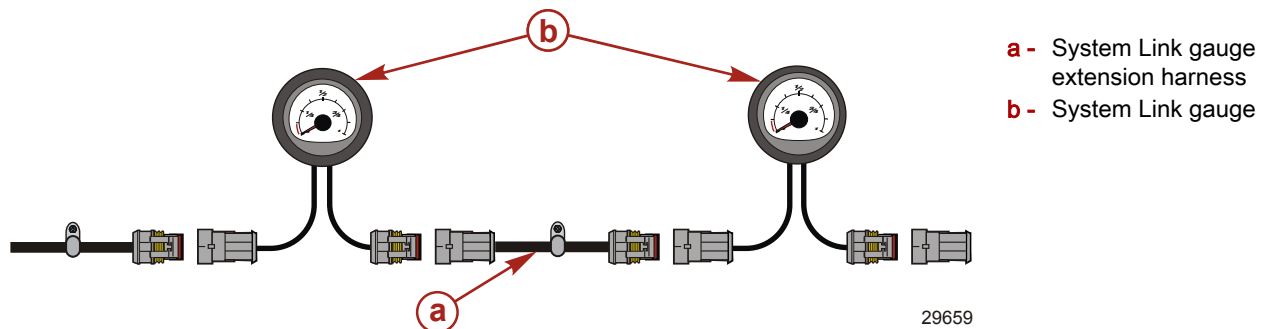
Example System Link gauge setup

- a - System Link connectors in series
- b - System Link connector to master gauge
- c - System Link gauges
- d - Weather cap

Each set of System Link gauges monitors one engine. In multiple-engine applications, install a System Link gauge set for each engine. In all cases, the System Link gauges connect to a master gauge or System Link adapter harness, which is connected to each engine's helm harness. For multiple-helm applications, the secondary helm instrumentation connects to the secondary helm harness in the same manner.

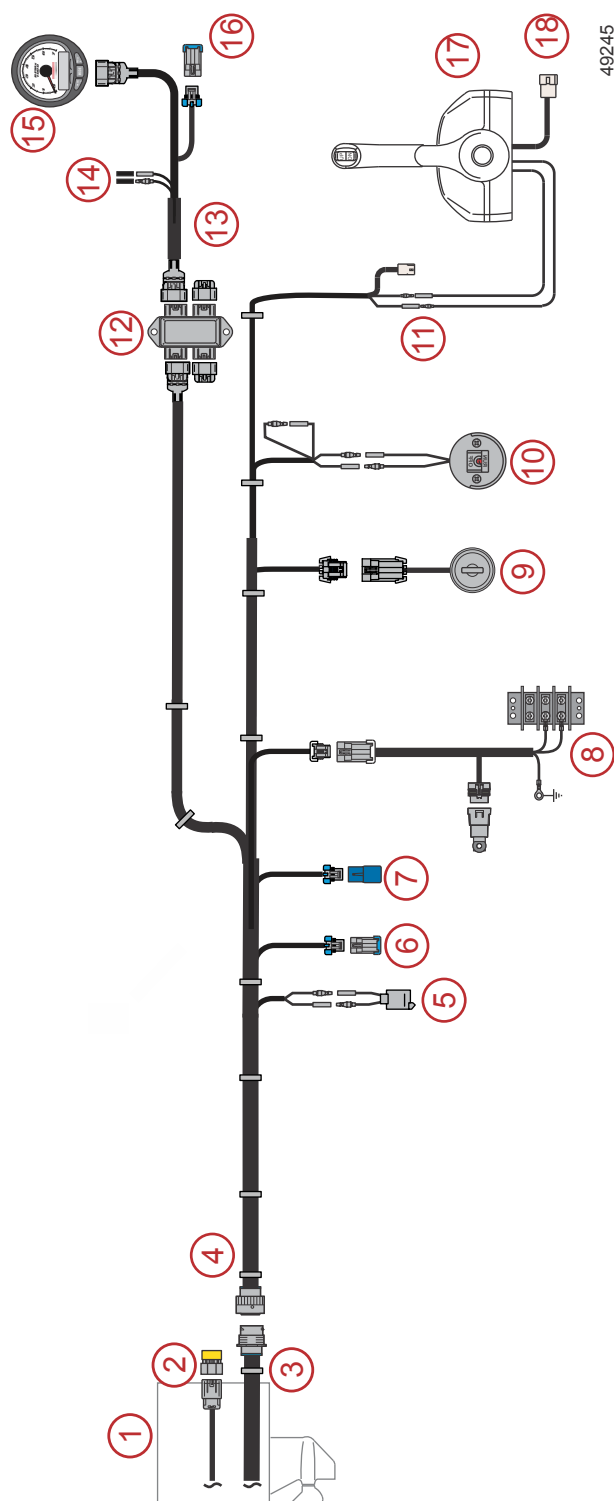
System Link Gauge Extension Harness Installation

The System Link gauge extension harness comes in five lengths, ranging from 15 cm to 9.1 m (6 in. to 30 ft). Install an extension harness anywhere in the System Link gauge series if you require additional gauge spacing or an alternative gauge mounting location. SmartCraft technology supports a System Link gauge series that does not exceed 9.1 m (30 ft) in overall length. SmartCraft supports one and two-helm installations with up to ten gauges per helm.



- a - System Link gauge extension harness
- b - System Link gauge

Single Engine, Single Helm with System Tachometer



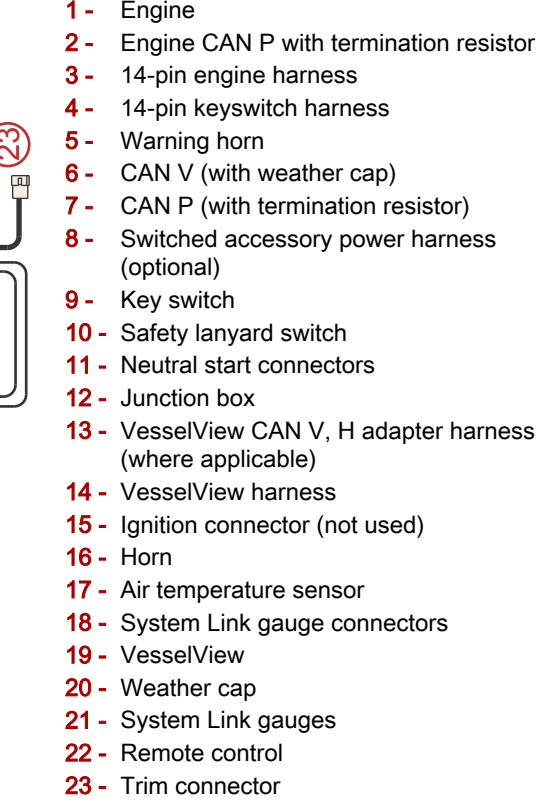
Single engine, single helm with System Tachometer

- 1 - Engine
- 2 - Engine termination resistor
- 3 - Engine 14-pin connector
- 4 - 14-pin keyswitch harness
- 5 - Warning horn
- 6 - CAN V (with weather cap)
- 7 - CAN P termination resistor
- 8 - Switched accessory power harness (optional)
- 9 - Key switch
- 10 - Safety lanyard switch
- 11 - Neutral start connector
- 12 - Junction box
- 13 - System Tach harness
- 14 - NMEA 0183 input
- 15 - System Tachometer
- 16 - System Link gauge connector (with weather cap)
- 17 - Remote control
- 18 - Trim connector

IMPORTANT: Confirm that all connectors are fully engaged and secure.

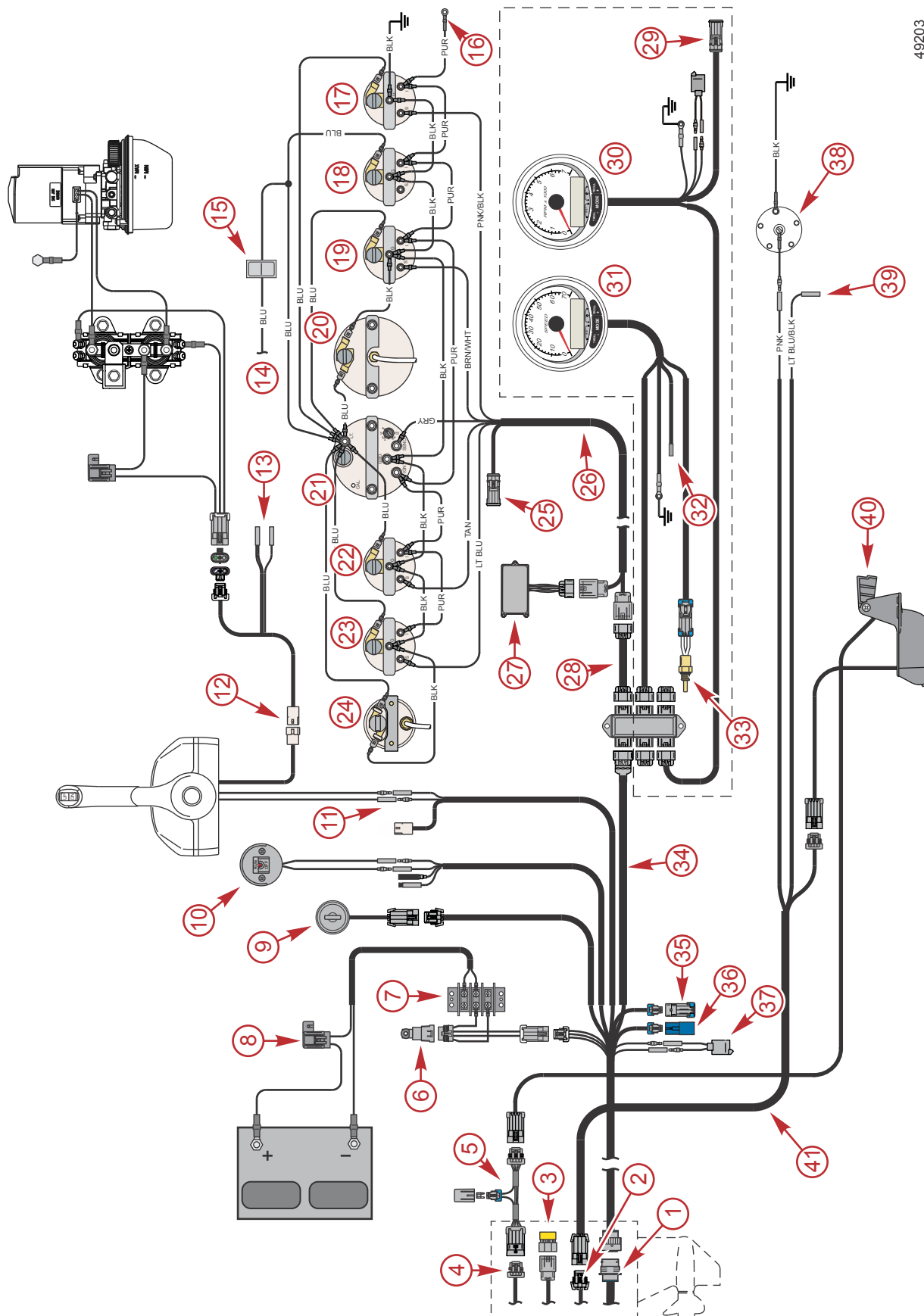
1. Confirm that all unused junction box and wiring connectors have weather caps to seal against contamination.
2. Confirm the placement of termination resistors at the engine 10-pin CAN P connector and the helm harness CAN P connector.

Single engine, single helm with VesselView and System Link gauges



1. Confirm that all unused junction box and wiring connectors have weather caps to seal against contamination.
2. Confirm the placement of termination resistors at the engine 10-pin CAN P connector and at the helm harness CAN P connector.

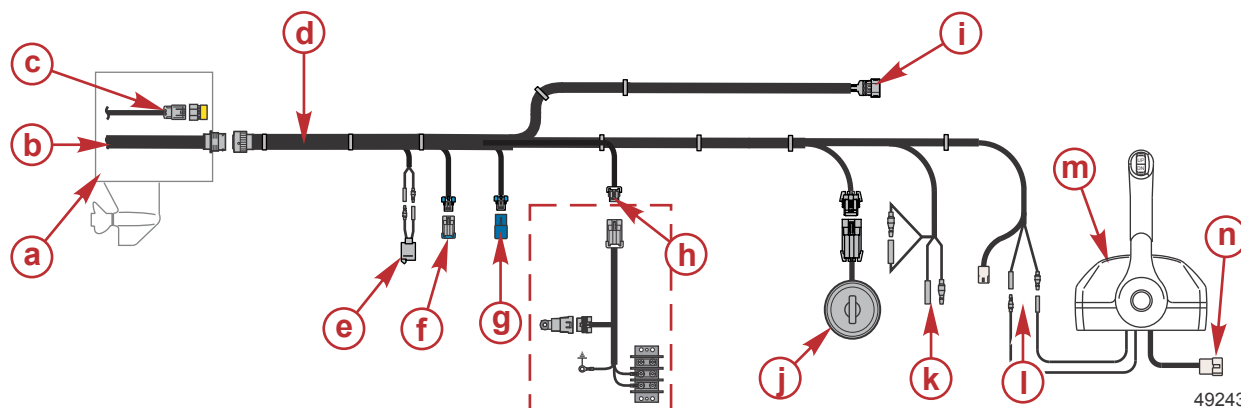
Notes:



14-pin SmartCraft engine with analog gauges and optional System Speedometer and Tachometer

- | | |
|---|--|
| 1 - 14-pin engine harness | 21 - Tachometer (analog) |
| 2 - 6-pin boat sensor harness | 22 - Temperature gauge (analog) |
| 3 - CAN P terminator | 23 - Oil pressure gauge (analog) |
| 4 - 4-pin diagnostic connector | 24 - Water pressure gauge (analog) |
| 5 - Diagnostic fuse harness (only used if depth transducer is installed) | 25 - System Link gauge connector |
| 6 - Accessory relay | 26 - AGI harness |
| 7 - Terminal block | 27 - AGI |
| 8 - 40-amp fuse | 28 - 10-pin female-female adapter harness |
| 9 - Key switch | 29 - System Link gauge connector |
| 10 - Safety lanyard switch | 30 - SC1000 System Tachometer (optional) |
| 11 - Neutral start safety switch connectors | 31 - SC1000 System Speedometer (optional) |
| 12 - Trim connector | 32 - NMEA 0183 connector (optional) |
| 13 - To trim limit switch | 33 - Air temperature sensor |
| 14 - To 12-volt switched power | 34 - 14-pin analog harness |
| 15 - Optional dash or dimmer switch | 35 - CAN V (not used) |
| 16 - To 12-volt switched power | 36 - CAN P terminator |
| 17 - Fuel gauge (analog) | 37 - Horn |
| 18 - Voltage gauge (analog) | 38 - Fuel tank sender |
| 19 - Trim gauge (analog) | 39 - Optional remote fuel tank |
| 20 - Speedometer (analog) | 40 - Transducer (transducer shown) |
| | 41 - SmartCraft boat sensor harness |

Data Harness: Single Engine, Single Helm



Single engine, single helm

- a** - Power package
- b** - Engine 14-pin connector
- c** - Engine CAN P and terminator
- d** - 14-pin keyswitch harness
- e** - Warning horn
- f** - CAN V (with weather cap)
- g** - CAN P (with termination resistor)
- h** - Accessory power connector (15-amp)
- i** - 10-pin SmartCraft connector
- j** - Key switch
- k** - Safety lanyard switch connectors
- l** - Neutral start connectors
- m** - Remote control
- n** - Trim connector

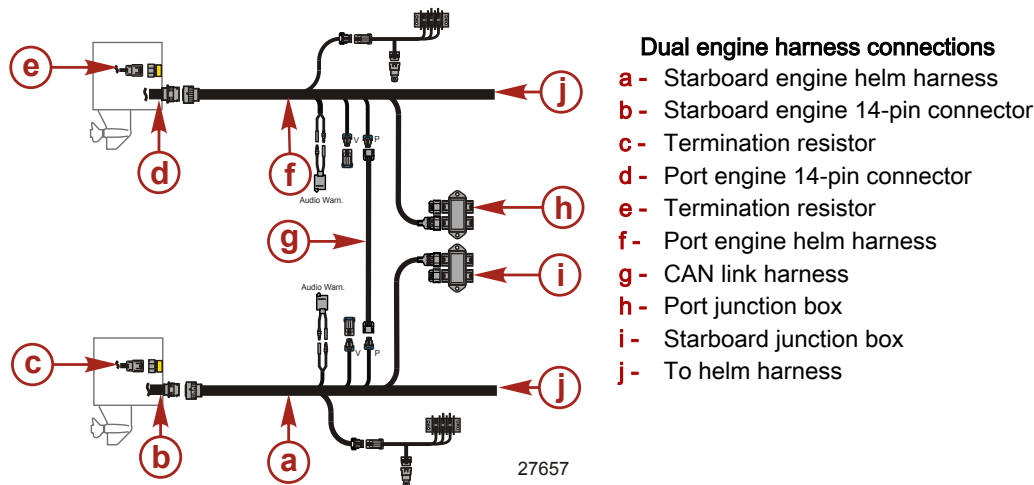
IMPORTANT: Ensure that all connectors are fully engaged and secure.

1. Ensure that a CAN P and CAN V termination resistor is installed at the engine.
2. Ensure that a termination resistor is installed at the helm harness CAN P connector.

Data Harness Connections: Dual Engine with Single Helm

IMPORTANT: Ensure that all connectors are fully engaged and secure.

1. Confirm the placement of termination resistors at both of the engines' CAN P and 10-pin CAN P-V connectors.
2. Confirm the installation of a CAN link harness between the starboard and port engines' CAN P connector.



3. Confirm that all unused junction box and wiring connectors are covered by weather caps or are otherwise sealed from contamination.

Multi-Station Considerations

Only station 1 gauges can be fully calibrated. Station 2 gauges have "Cal2" disabled, and copy all "Cal2" settings (external sensors, tank types and calibrations, and sensor offsets) from the corresponding Station 1 gauge. For triple-station installations, with the same type of System gauges at all stations, set the System gauges at one station as "Stn1" (master), and gauges at the other stations as "Stn2" (slave). System gauges borrow "Cal2" settings only from same type gauges (in other words, System Monitor borrows from System Monitor, not from System Tach or VesselView). If different gauge types are used at different stations, there must be a station 1 for each type of gauge and each engine.

Multiple Engine and Multi-Station Setup

IMPORTANT: Always complete AutoDetect on starboard station 1 Monitor first.

- All PCMs should be active and connected to the CAN bus prior to performing AutoDetect.
- The first unit to perform AutoDetect will assume the starboard station 1 position if a starboard PCM is detected.
- An error will result if no starboard PCM is detected or if multiple starboard PCMs are detected. If no PCM is detected, the engine type can be set in Cal2, but only the first time through.
- If the unit detects a starboard station 1 gauge already on the CAN bus, the unit will assume another setting based on the engines and gauges detected.
- System Monitor, SC1000 System Tach and Speed choose defaults during the AutoDetect sequence based on what is found on the CAN bus.
- System Tach AutoDetect default settings are shown on the face of the gauge.
- Starboard station 1 gauges must be calibrated first. The suggested method is to perform a master reset on all gauges, but to not start the AutoDetect until all gauges are waiting. System Monitor and SC1000 System Tach will assume locations in the following order:
 - Starboard station 1
 - Port station 1 (if port PCM found)
 - Starboard station 2
 - Port station 2

In three-station installations, the master station is station 1; all others are set as station 2. Station 2 gauges borrow trim, tank, and sensor calibrations from station 1.

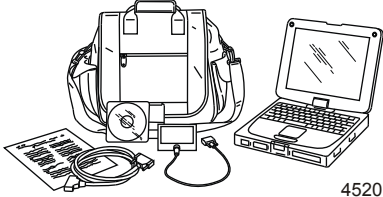
Electrical System

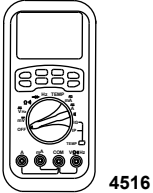
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Special Tools

Computer Diagnostic System (CDS)	Available through Bosch Automotive Service Solutions
	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: Bosch Automotive Service Solutions 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

DMT 2004 Digital Multimeter	91-892647A01
	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Engine Harness Legend

Wire Splice Description

Splice Number	Description
100	5-volt transducer ground
101	5-volt transducer power
102	Wake line
103	12-volt 50-amp protected
104	12-volt engine ground
105	12-volt from MPR
106	Switched 12-volt fused
107	12-volt fused
108	12-volt fused to all injectors
109	Transmission and drive lubricant
110	Injectors 1, 4, 6
111	Injectors 2, 3, 5
113	Tachometer lead
114	Ignition coil and coil driver

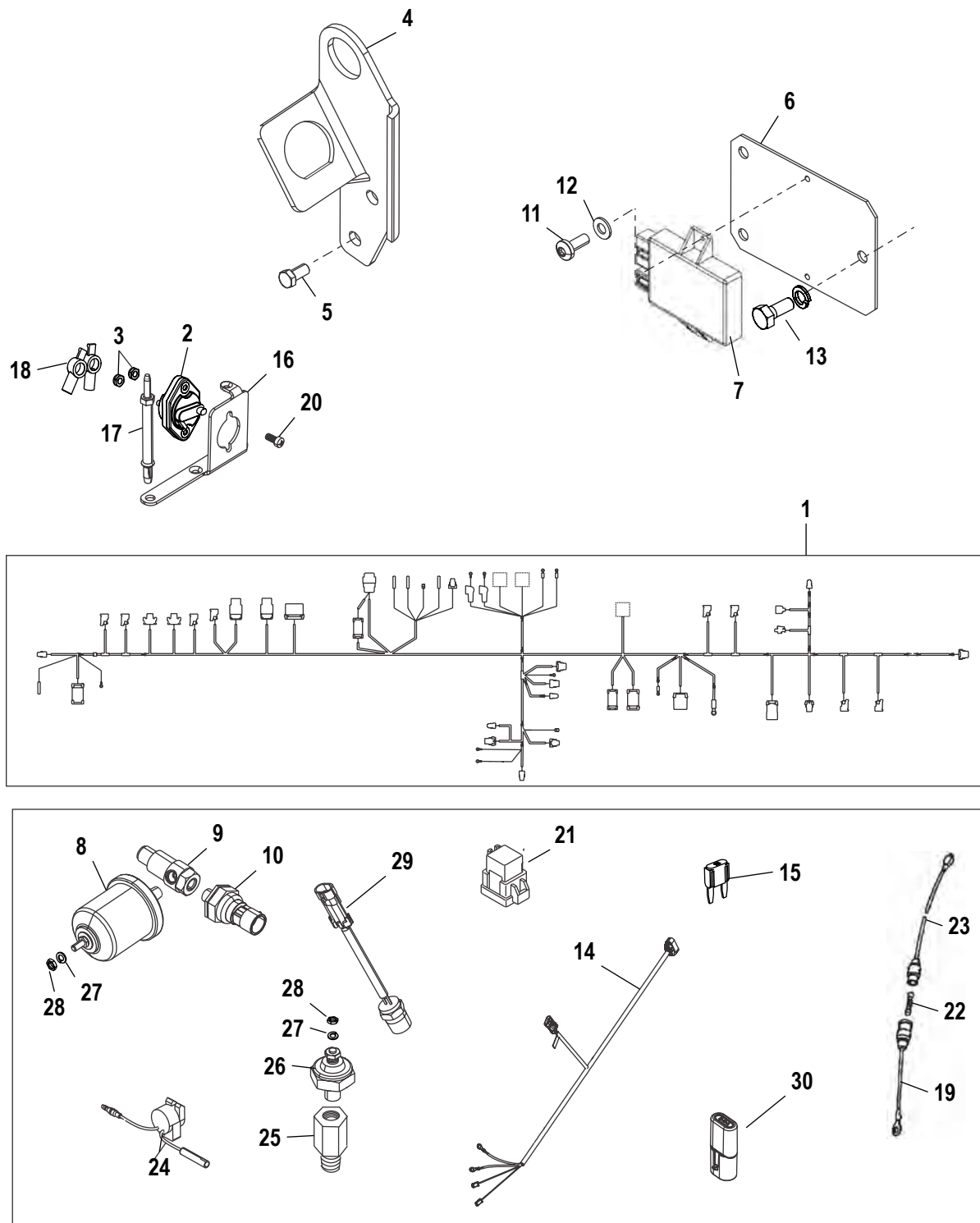
Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

NOTE: Refer to the **MerCruiser Diagram Binder** for 14-pin 4.3L TKS models and complete 4.3L MPI wiring harness diagrams.

Electrical Components

4.3L TKS Models

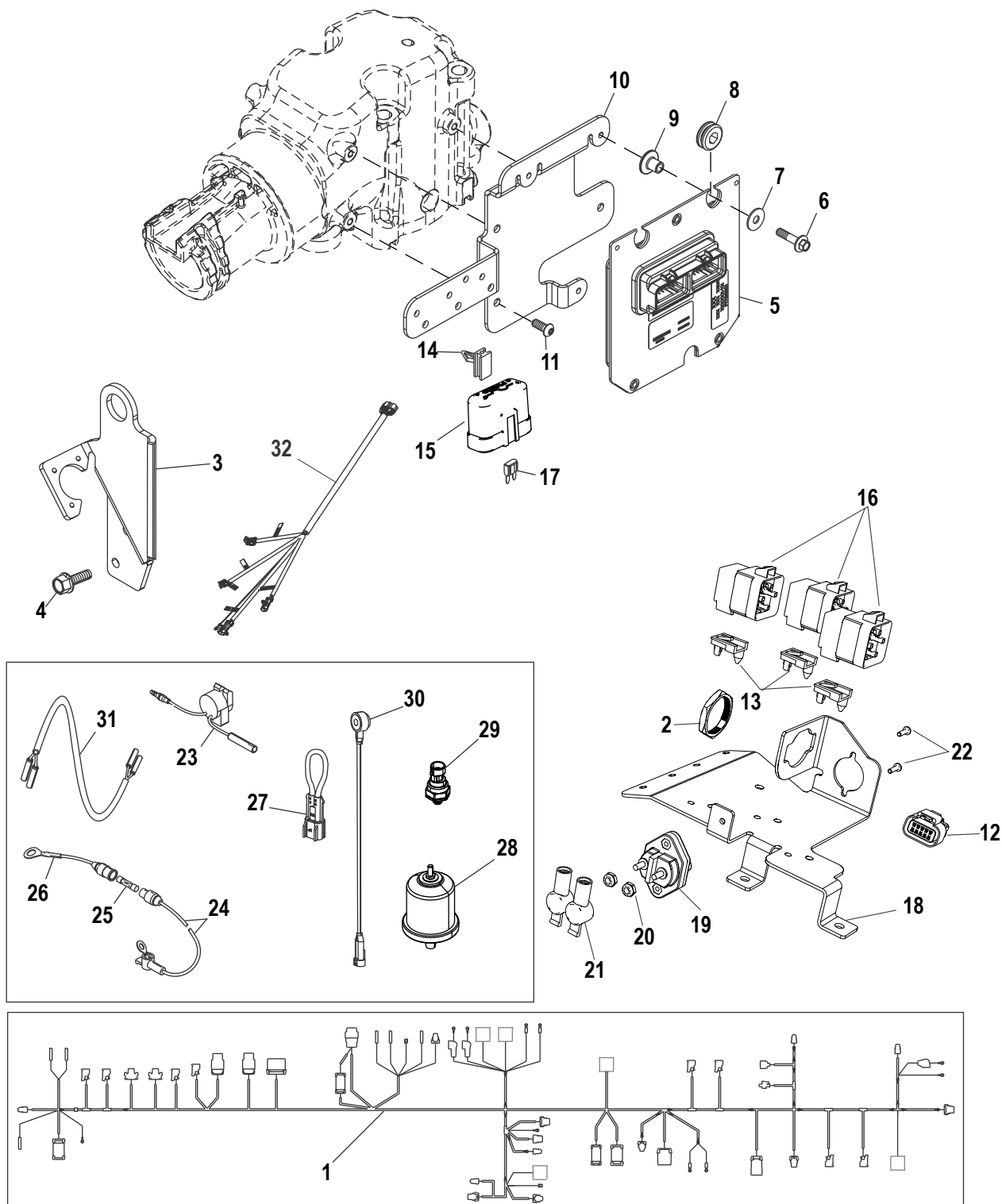


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4.3L TKS Models

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Engine harness assembly			
2	1	Circuit breaker			
3	2	Stainless steel nut (#10-32)			
4	1	Lifting eye bracket			
5	2	Screw (0.375-16 x 0.750)	38	–	28
6	1	Bracket			
7	1	Ignition control module (ICM)			
8	1	Oil pressure sender (gauge)	13.6	120	–
9	1	Fitting			
10	1	Switch			
11	2	Screw (#10-32 x 0.500)	3.6	32	–
12	2	Washer (0.203 x 0.406 x 0.040)			
13	3	Screw and lockwasher	10.8	96	–
14	1	Transom harness assembly			
15	1	Fuse (15-amp accessory)			
15	1	Fuse (20-amp TKS)			
16	1	Bracket			
17	1	MerCathode mounting stud			
18	2	Insulator boot (black)			
19	1	Cable assembly (red)			
20	2	Screw (#8-32 x 0.625)	2.3	20	–
21	1	Relay			
22	1	20-amp fuse in-line (shown) or 5-amp blade			
23	1	Cable assembly (red/purple)			
24	1	Alarm			
25	1	Adapter fitting	27	–	20
26	1	Switch assembly	20	177	–
27	2	Stainless steel lockwasher (#10)			
28	2	Stainless steel nut (#32-10)			
29	1	TKS thermal switch (normally open 130-110 degrees)			
30	1	Diode assembly			

4.3L MPI Models



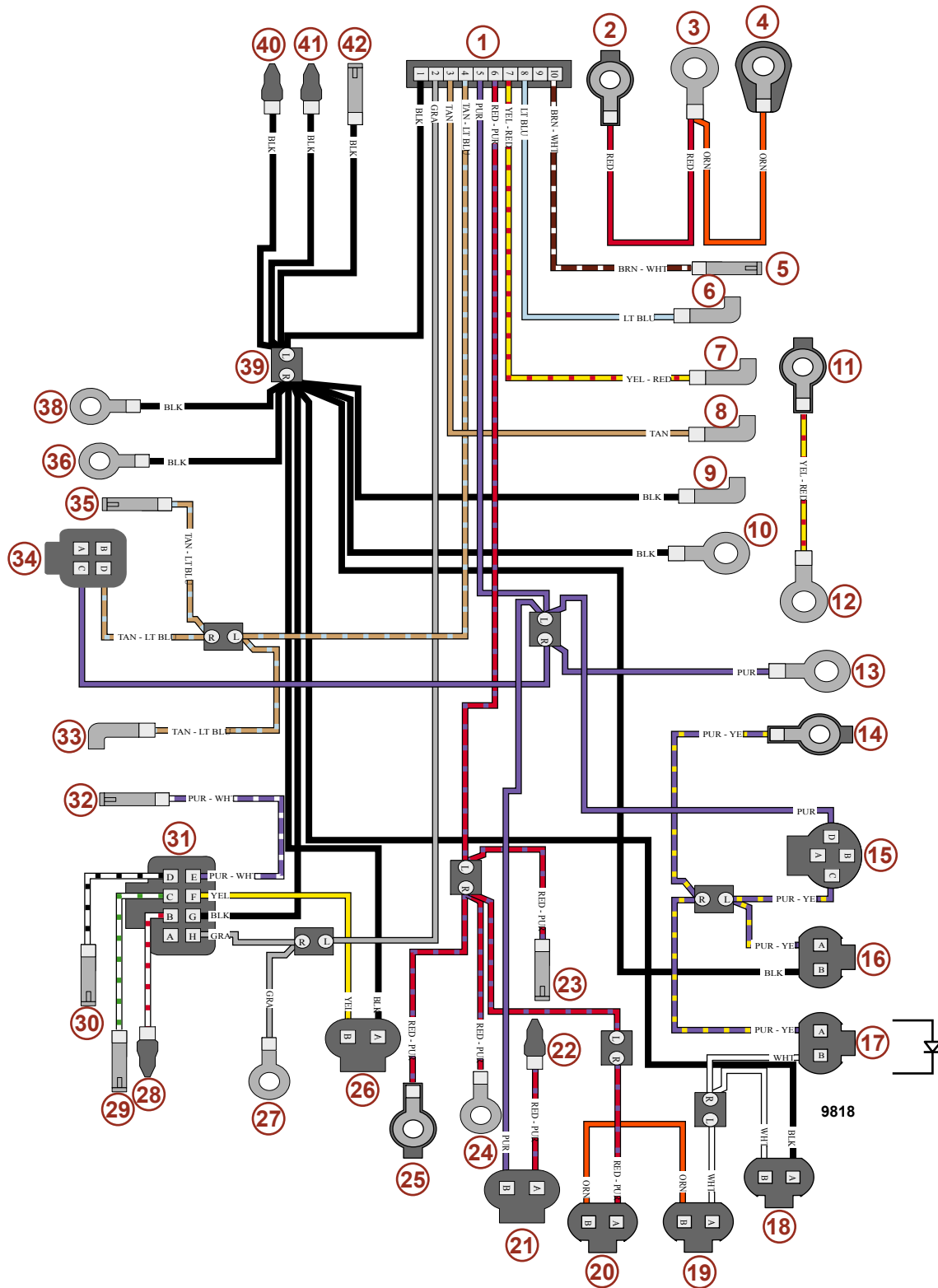
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4.3L MPI Models

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Engine harness assembly			
2	1	Black nylon nut (engine harness connector)			
3	1	Bracket			
4	2	Screw (0.375-16 x 0.750)	38	–	28
5	1	Engine control module (ECM)			
6	3	Screw (M6 x 25)	8.1	72	–
7	3	Washer			
8	3	Grommet			
9	3	Bushing			
10	1	Bracket			
11	3	Screw (0.250-20 x 6.25) Torx	12.2	108	–
12	1	Terminator (CAN 1 and CAN 2)			
13	3	Relay mounting clip			
14	1	Fuse mounting block clip			
15	1	Fuse cover			
16	3	Relay			
17	2	Fuse (blue 15-amp)			
17	3	Fuse (yellow 20-amp)			
18	1	Bracket			
19	1	Circuit breaker			
20	2	Stainless steel nut (#10-32)			
21	1	Insulator boot (black)			
22	2	Screw (#8-32 x 0.650)	2.3	20	–
23	1	Alarm			
24	1	Cable assembly (red/purple)			
25	1	20-amp fuse in-line (shown) or 5-amp blade			
26	1	Cable assembly (red)			
27	1	Jumper/connector (Bravo)			
28	1	Oil pressure sender (gauge)	13.6	120	–
29	1	Water pressure sensor (50 psi)	13.6	120	–
29	1	Oil pressure sensor (100 psi)	20	177	–
30	1	Knock sensor with screw	20	177	–
31	1	Lube bottle extension harness			
32	1	Transom harness assembly			

10-Pin 4.3L TKS Wiring Harness Diagram

4.3L TKS

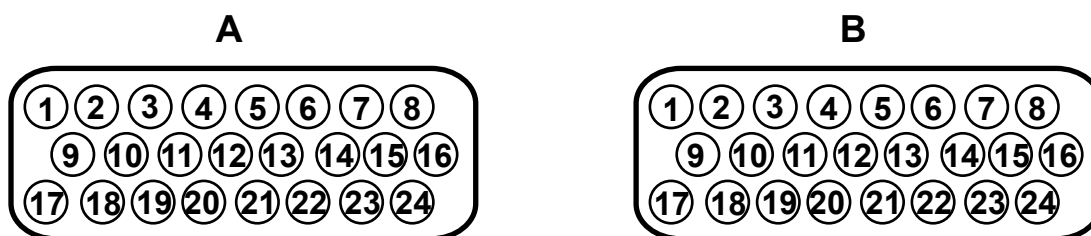


4.3L TKS

Ref. No.	Description
1	10-pin connector
2	50-amp circuit breaker
3	90-amp starter fuse
4	Alternator output
5	Trim sensor
6	Oil sender (analog gauge)
7	Starter solenoid (cranking)
8	Temperature
9	Starter solenoid (-)
10	Ground
11	"S" terminal on starter solenoid
12	Starter solenoid (on engine)
13	Ignition coil
14	"R" terminal on starter solenoid
15	Oil pressure switch
16	Fuel pump
17	Diode
18	Turn key start module
19	Temperature switch
20	20-amp fuse
21	Alternator sensor and turn on
22	Alternator disconnect
23	Alternator disconnect
24	Starter solenoid
25	Circuit breaker
26	Oil pressure switch
27	Ignition coil
28	Distributor
29	Distributor
30	Ignition interrupt
31	Ignition control module (view from wire end)
32	Timing
33	Temperature switch
34	Ignition control module (view from wire end)
35	Transmission temperature
36	Alternator ground
38	Engine ground
39	Splice - typical
40	Ignition interrupt
41	Trim sender
42	Transmission temperature

10-Pin MPI Wiring Harness Diagrams

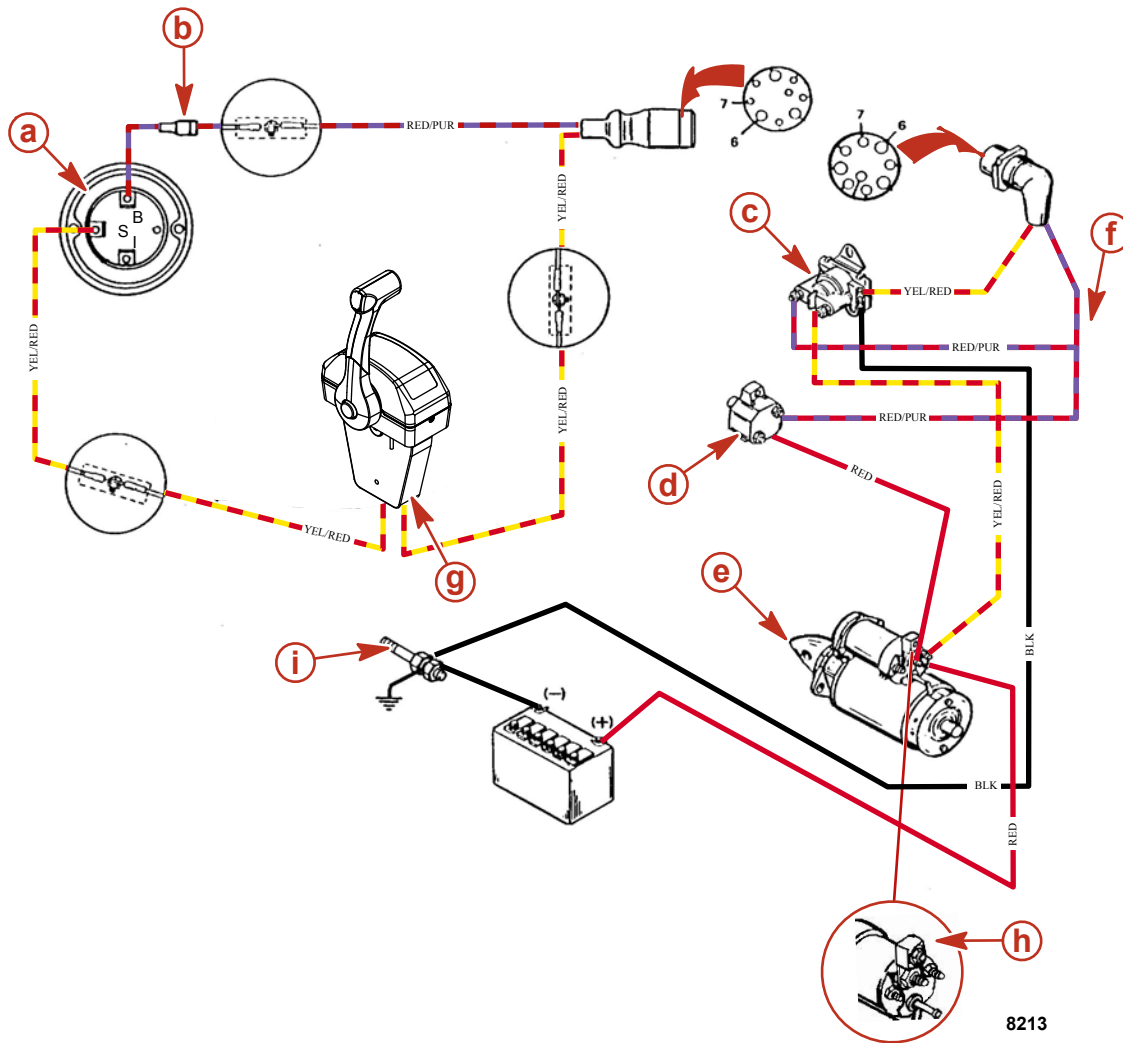
10-Pin ECM 555 Pinouts



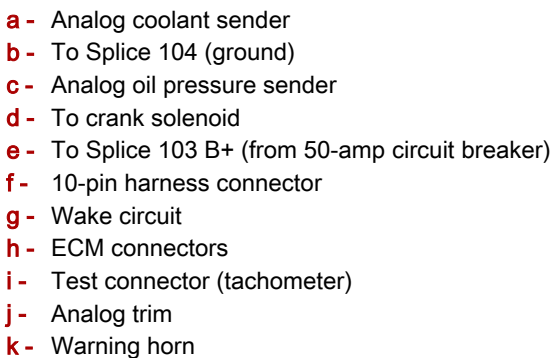
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Pin	ECM 555SD	4.3L MPI	Pin	ECM 555SD	4.3L MPI
A1	Empty	Empty	B1	Sender ground	Black/pink
A2	Fuel injector bank 2	Lt green/white	B2	MAT signal	Brown/yellow
A3	Empty	Empty	B3	MAP signal	Lt green
A4	CAN 1 (+)	White	B4	Fuel level 1 signal	Lt blue/black
A5	Scan (-)	White/purple	B5	Empty	Empty
A6	Empty	Empty	B6	Empty	Empty
A7	Knock sensor	Yellow/dk blue	B7	Oil pressure signal	Dk blue/black
A8	Trans temp/lube bottle	Dk blue/brown	B8	Steering angle signal	Pink/dk blue
A9	Warning horn	Brown/dk blue	B9	Paddle wheel signal	Yellow/gray
A10	Tach sig out	Gray/white	B10	CPS signal	Tan/black
A11	CAN 1 (-)	Lt blue	B11	Sea pump signal	Dk blue/white
A12	Scan (+)	White/black	B12	Pilot signal	White/dk blue
A13	Empty	Empty	B13	Digital trim signal	Orange/white
A14	Knock sensor	Blue/yellow	B14	ECT signal	Yellow
A15	E-stop (through CAN)	Dk green/yellow	B15	Empty	Empty
A16	Ground	Black	B16	Empty	Empty
A17	Fuel injector bank 1	Lt green/purple	B17	Empty	Empty
A18	Empty	Empty	B18	Wake circuit	Purple
A19	Fuel pump relay control	Dk green	B19	Shift interrupt signal	Yellow/purple
A20	IAC valve control	Black/dk green	B20	TPS signal	Dk blue/orange
A21	Gear position switch	Yellow/dk green	B21	Sender power	Gray
A22	MPR control	Purple/dk green	B22	Sea temp signal	White/yellow
A23	MPR output (to ECM)	Pink	B23	EST (coil control)	White/dk green
A24	Ground	Black	B24	Empty	Empty

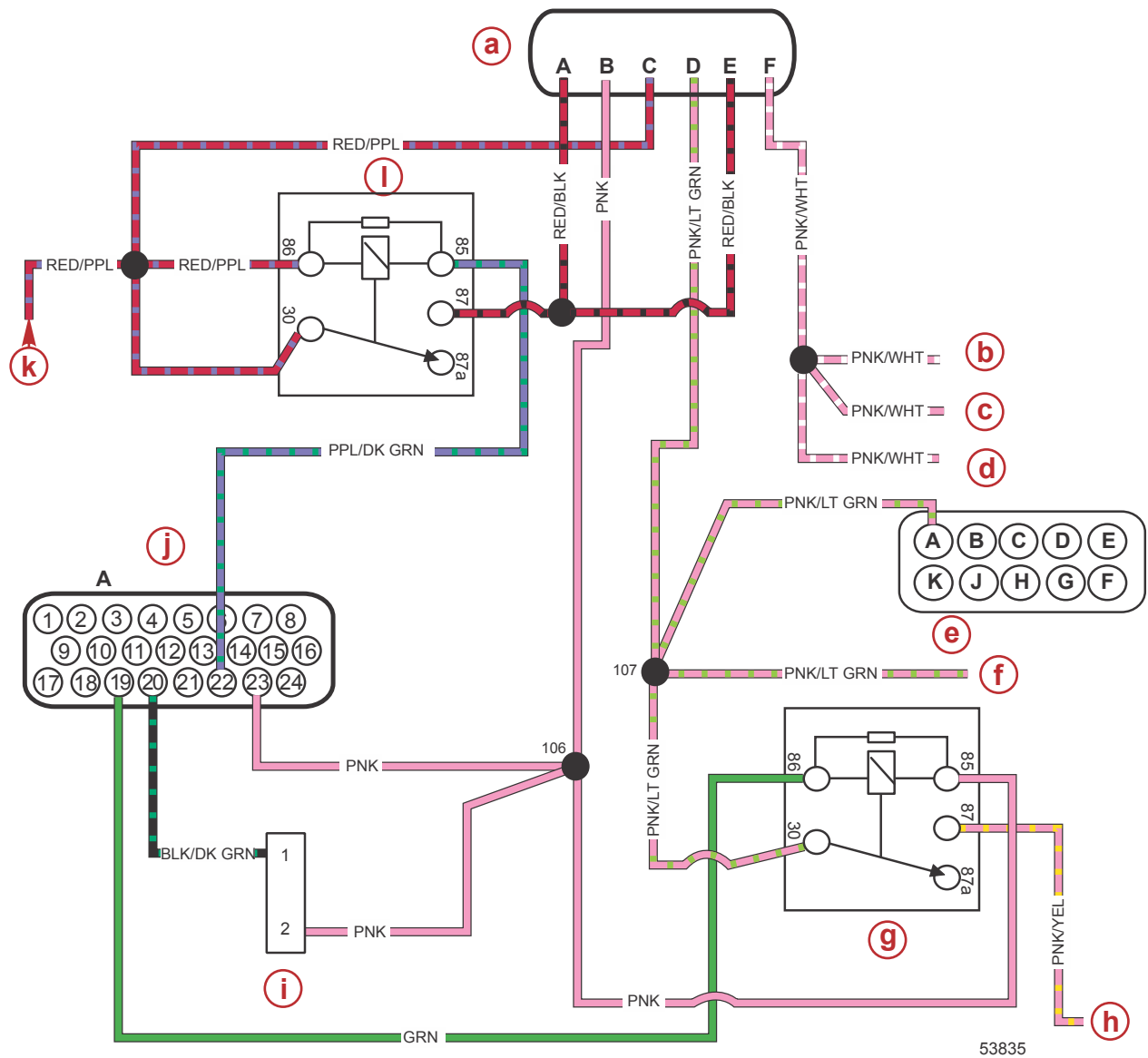
Typical Starting System Components—10-Pin Engine Harness



- a -** Ignition switch
- b -** 20-amp fuse
- c -** Starter solenoid or relay
- d -** 50-amp circuit breaker
- e -** Starter motor
- f -** Wire junction
- g -** Neutral safety switch
- h -** 90-amp fuse
- i -** Ground (-)

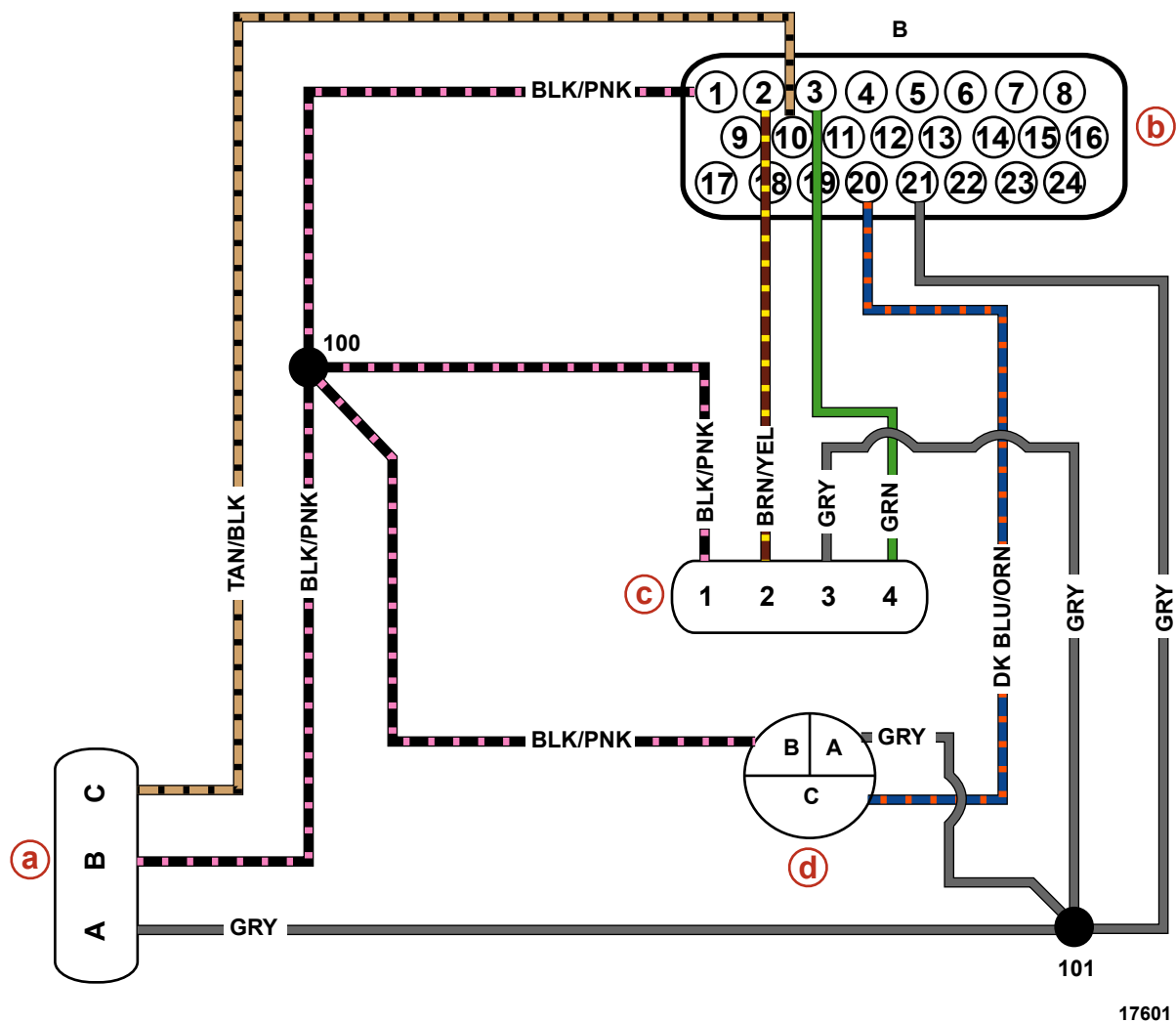


Fuses, Idle Air Control (IAC), and Relays



- a** - Fuse holder
- b** - To pin A of all fuel injectors
- c** - To pin A of ignition coil
- d** - To pin A of coil driver
- e** - CAN connector
- f** - To alternator pin B sensing wire
- g** - Fuel pump relay
- h** - Cool fuel pump
- i** - IAC
- j** - ECM 555 connector A
- k** - To 50-amp circuit breaker
- l** - Main power relay (MPR)

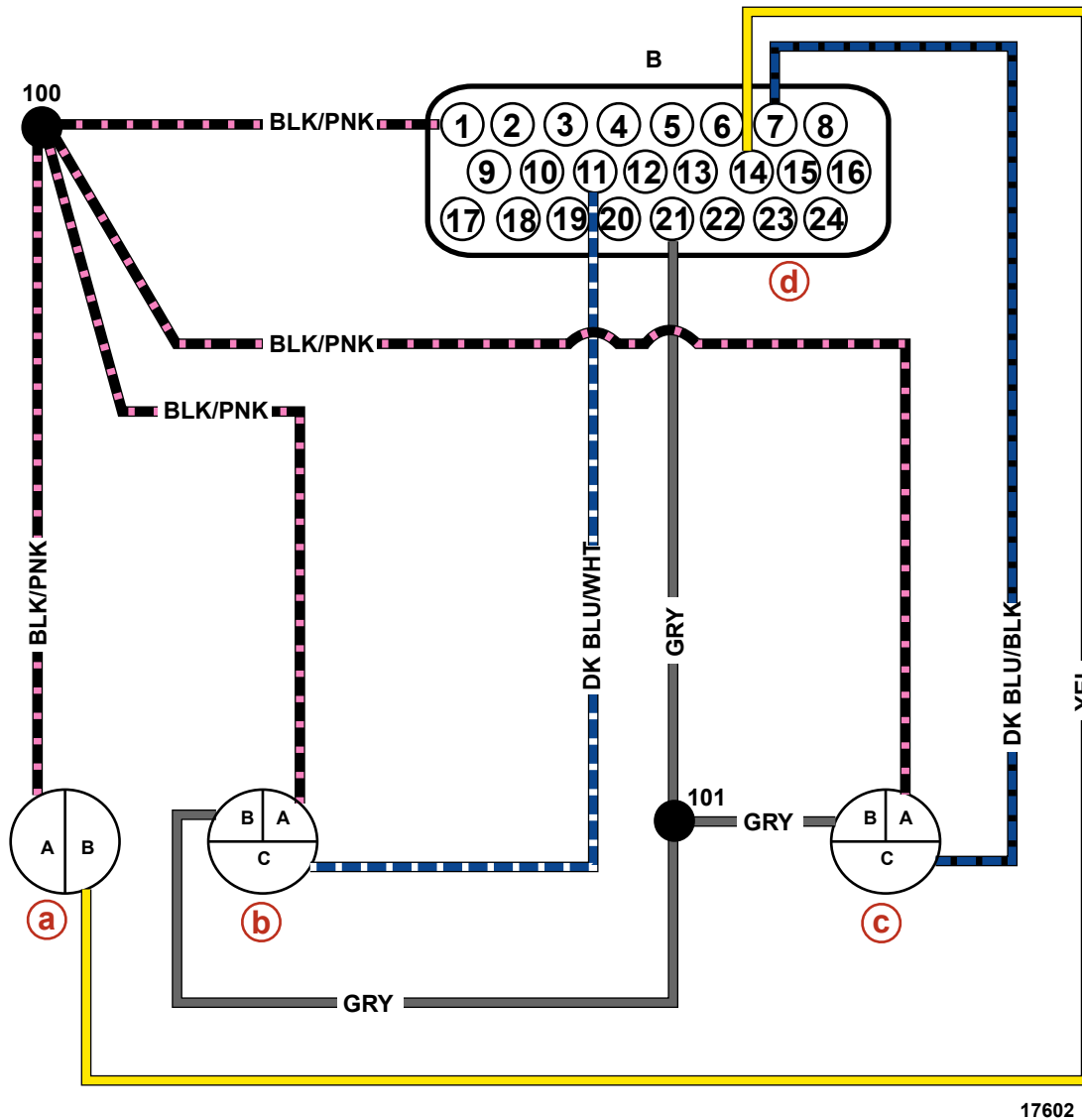
Manifold Air Pressure and Temperature, Crankshaft Position, and Throttle Position Sensors: V6 Engines



- a** - Crankshaft position sensor
- b** - ECM 555
- c** - Manifold air pressure/Manifold air temperature
- d** - Throttle position sensor

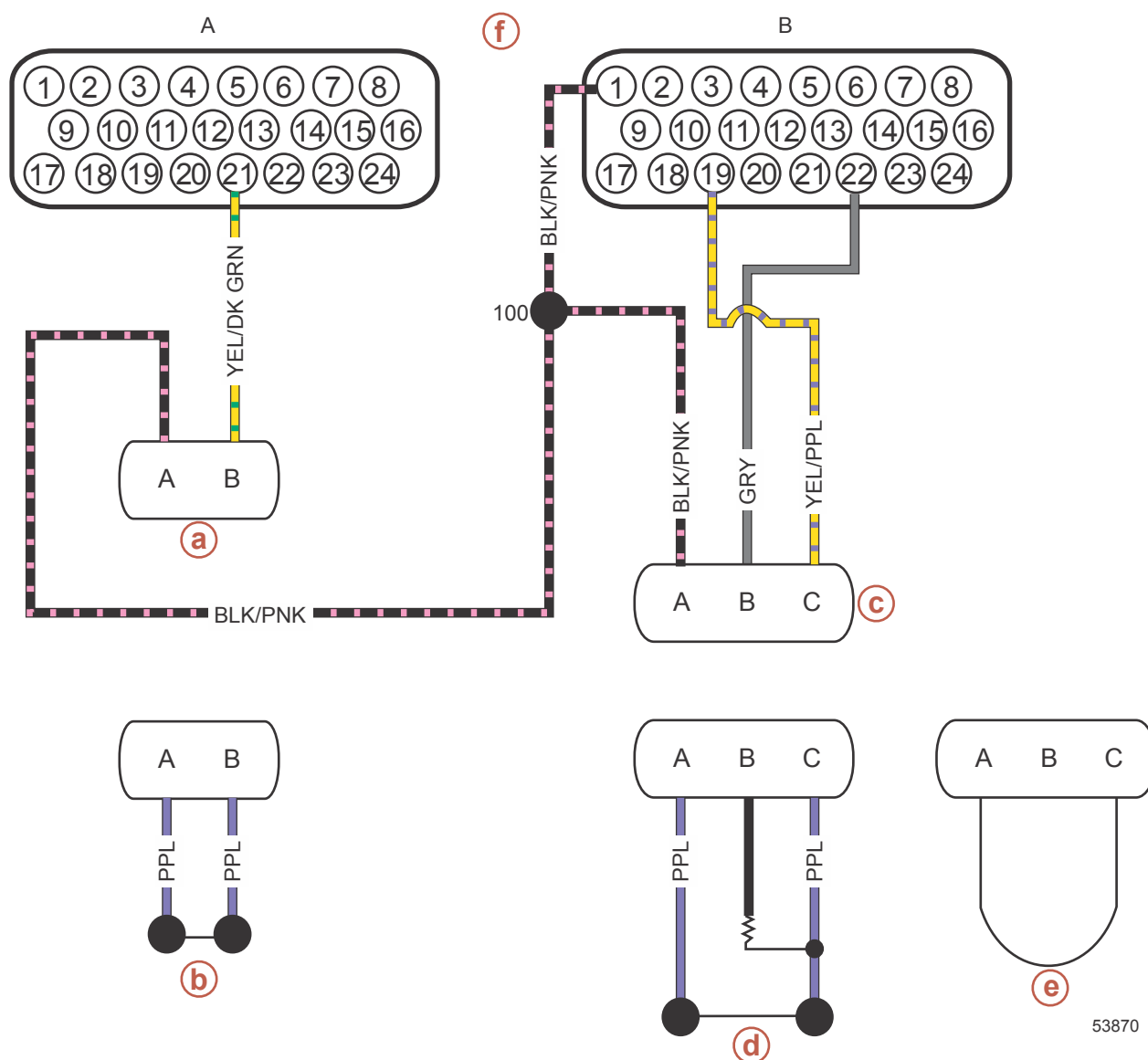
NOTE: The **green** wire coming from ECM555 connector B pin 3 may be **light green** on some models.

Engine Coolant Temperature, Seawater Pump, and Oil Pressure Sensors



- a** - Engine coolant temperature
- b** - Seawater pump pressure
- c** - Oil pressure
- d** - ECM 555 connector B

Gear Indicator and Shift Interrupt



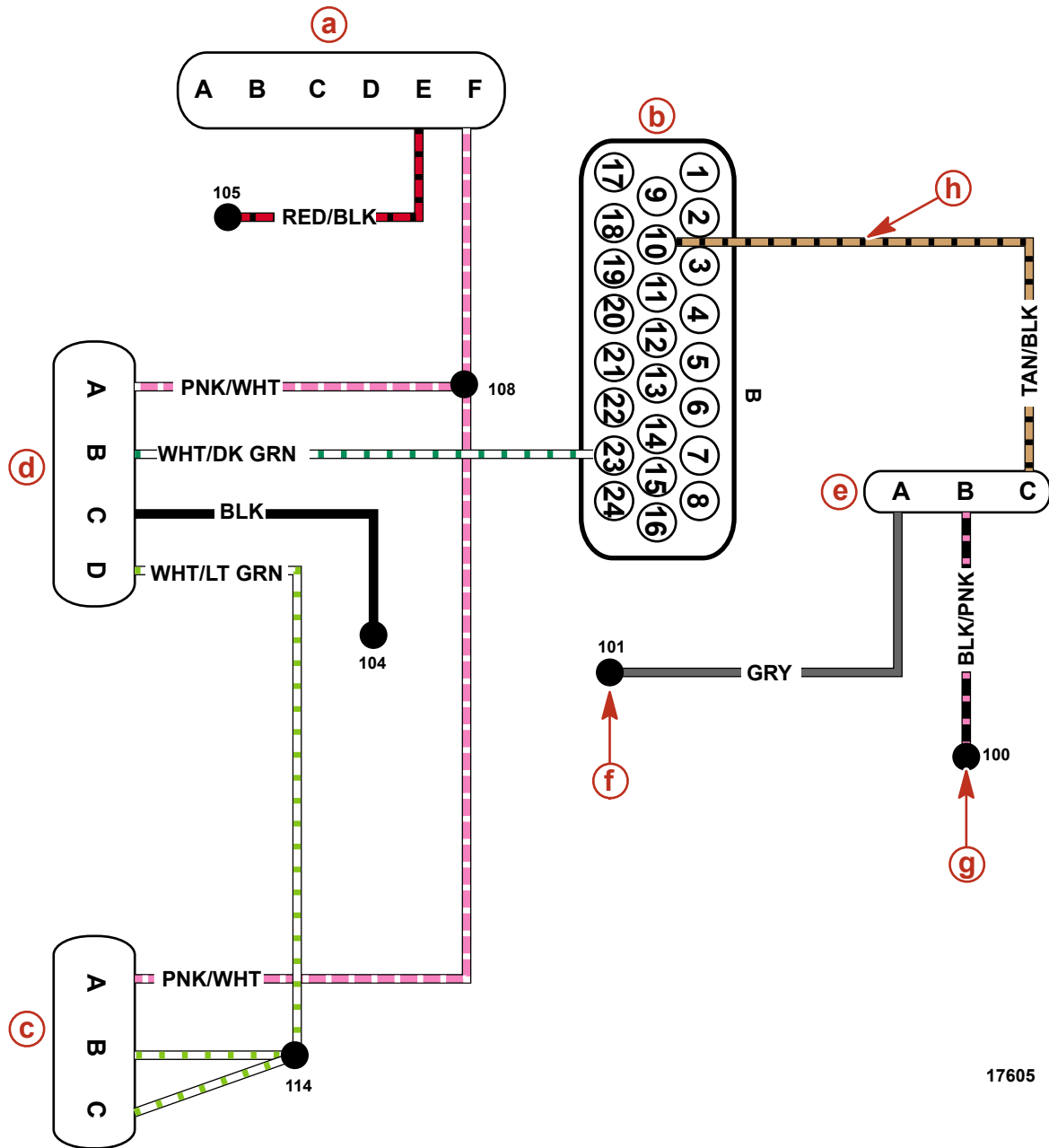
53870

- a** - Gear indicator connector
- b** - Gear indicator switch
- c** - Shift interrupt switch connector
- d** - Shift interrupt switch
- e** - Jumper plug (Bravo models)
- f** - ECM 555 connectors A and B

The gear indicator switch used on 4.3L MPI Alpha and Bravo models is a normally closed switch (in neutral position) and opens when the shift bracket is in the forward or reverse gear position.

The shift interrupt switch used on 4.3L MPI Alpha models is a normally closed switch (in neutral position) and is momentarily opened when shifting in-or-out of gear.

Ignition System Without Cam Position Sensor

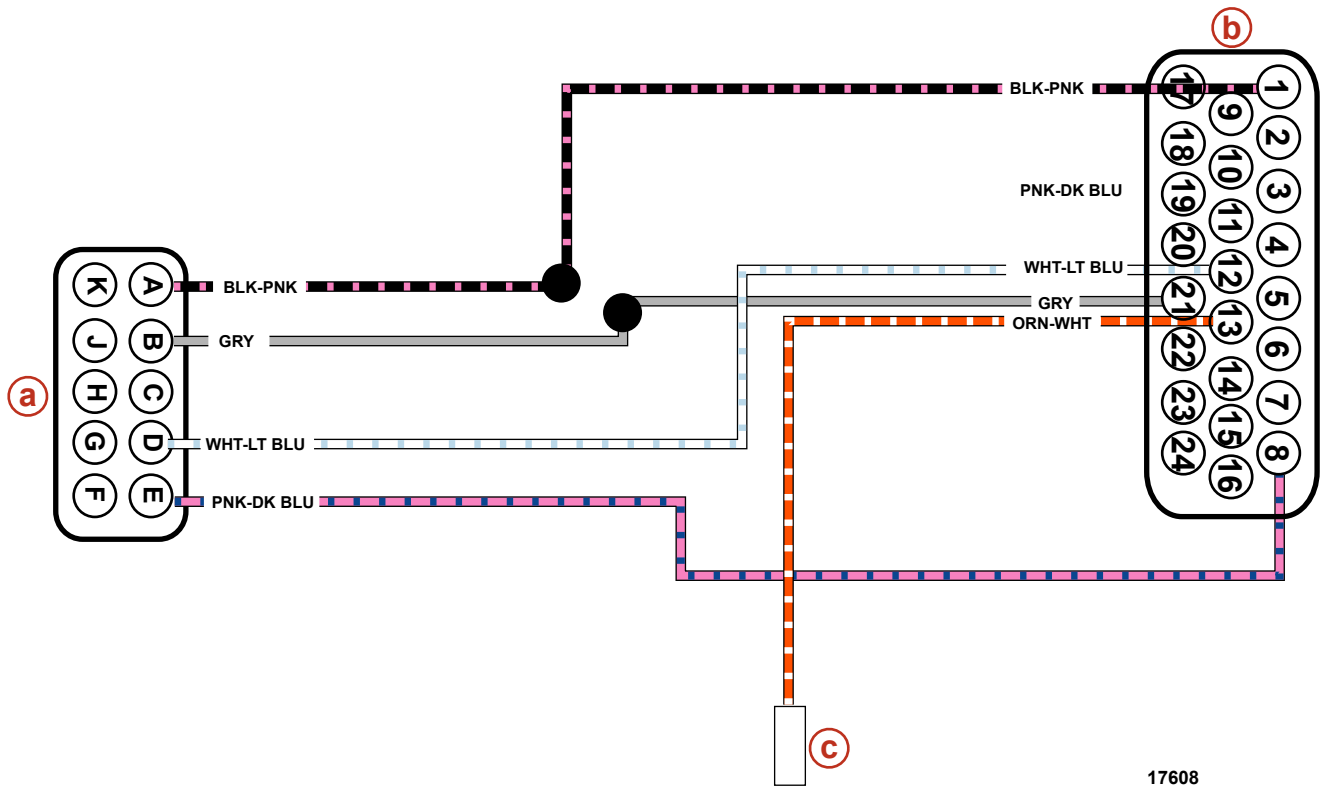


- a** - Fuse holder
- b** - ECM 555 connector B
- c** - Ignition coil
- d** - Ignition coil driver module
- e** - CPS connector
- f** - 5-volt power
- g** - 5-volt ground
- h** - CPS signal



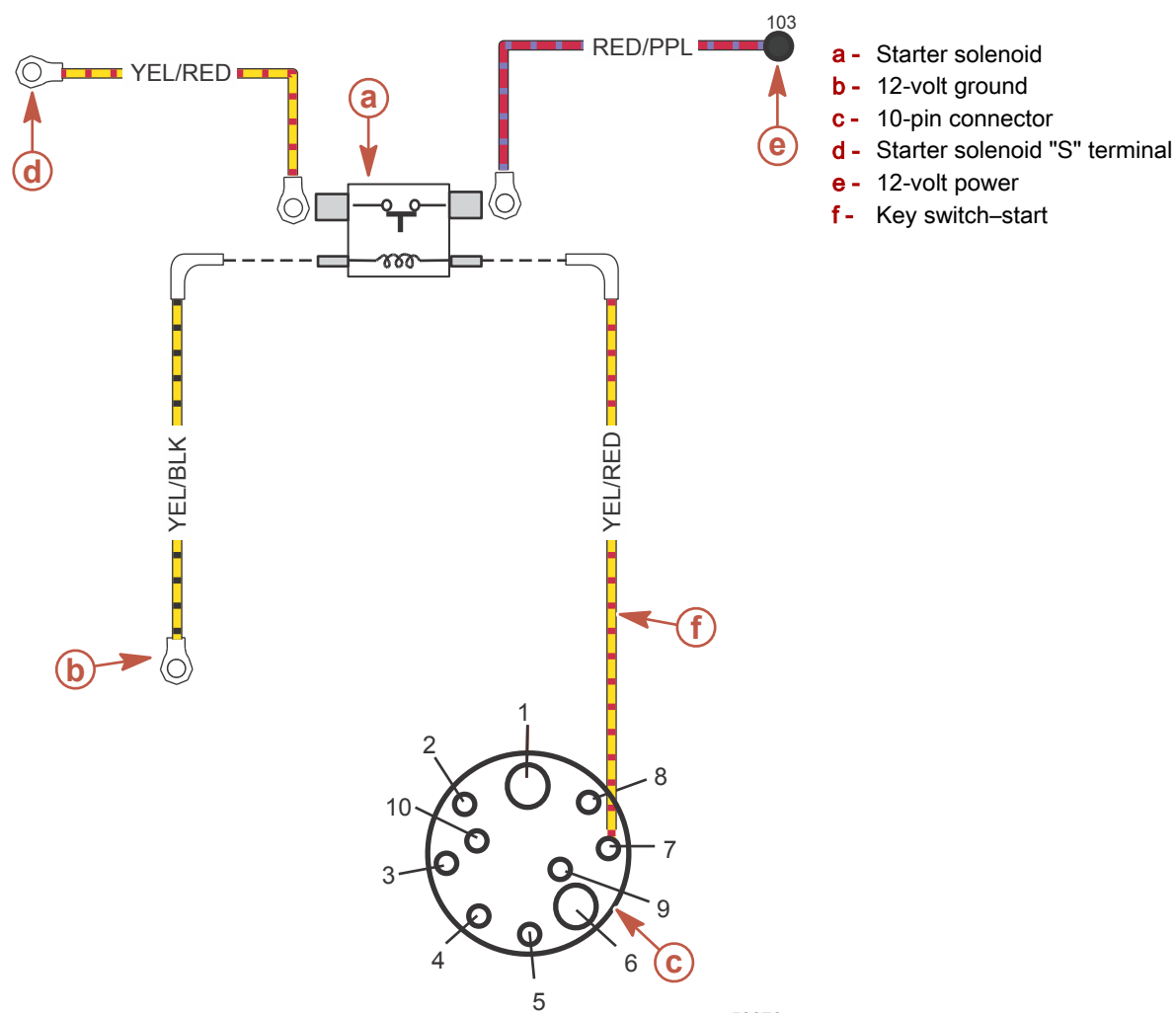
- 90-8M0086018 AUGUST 2013

Transom Harness Connector (to Engine)



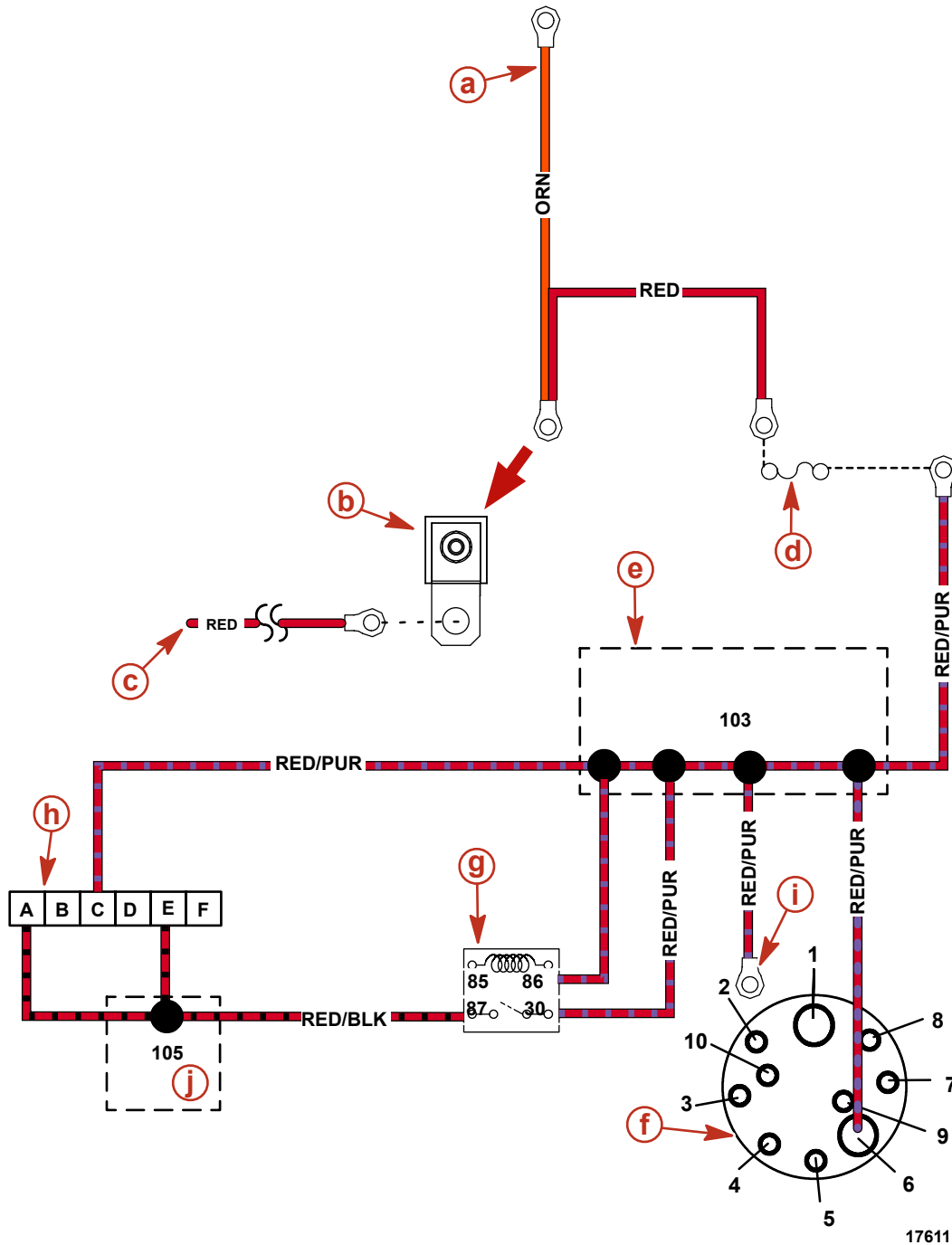
- a** - Transom harness connector (on engine harness); Pin D (pitot signal), Pin E (steering signal)
- b** - ECM 555 connector B
- c** - Digital trim

Starter Solenoid Circuit



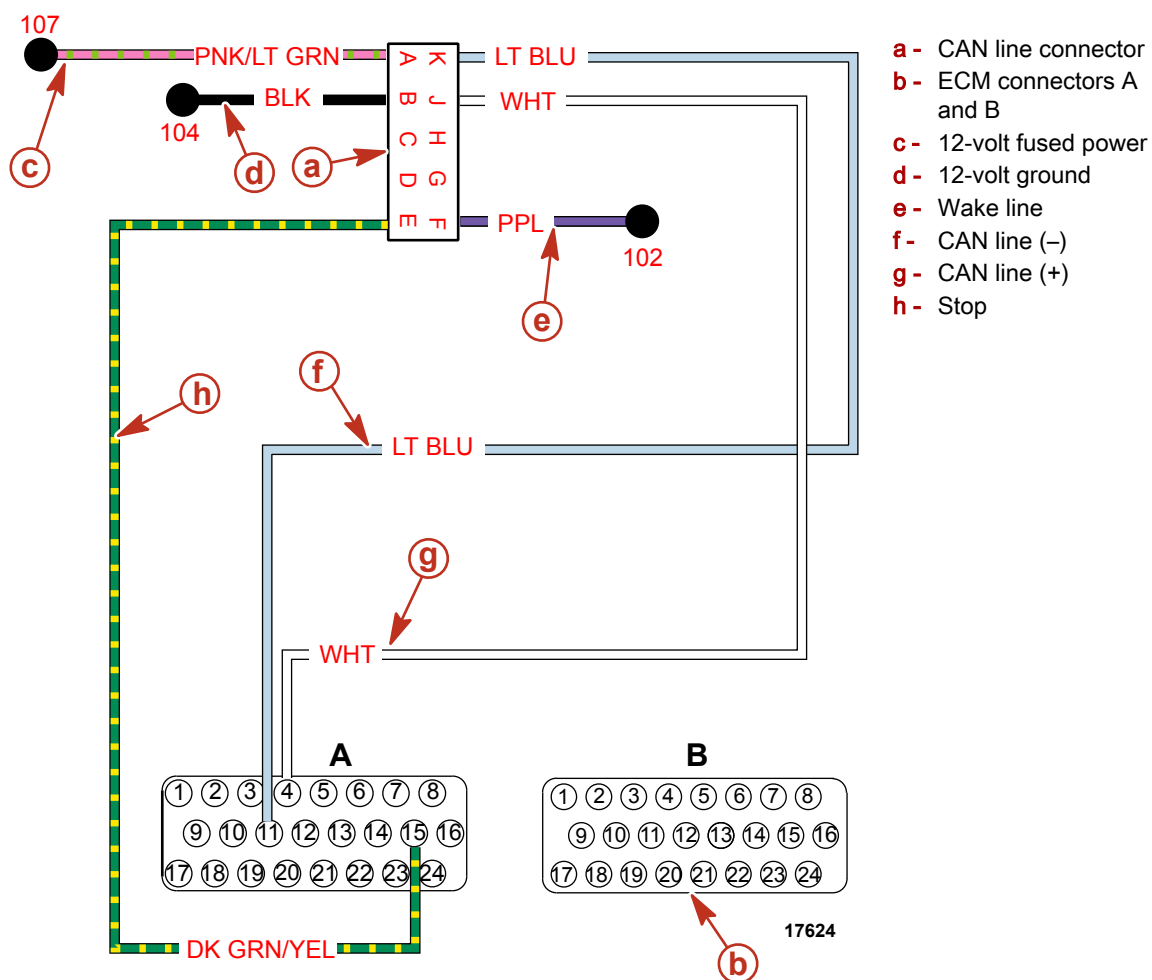
53876

Alternator Output Circuit



- a - From alternator
- b - 90-amp fuse on starter
- c - To battery
- d - 50-amp circuit breaker
- e - Splice 103
- f - 10-pin
- g - Main power relay
- h - Fuses
- i - Starter solenoid power
- j - Splice 105

Controller Area Network (CAN) Circuit

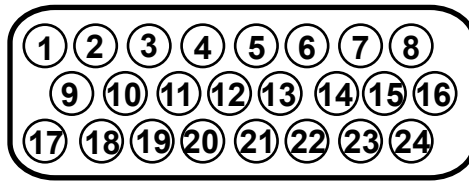


The CAN circuit provides digital information to the helm on models equipped with SmartCraft gauges. A malfunction in the CAN circuit will set a fault.

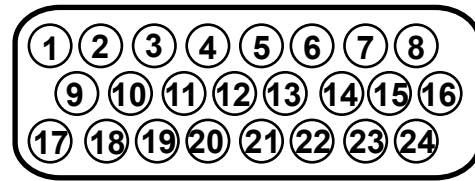
14-Pin MPI Wiring Harness Diagrams

14-Pin ECM 555 Pinouts

A



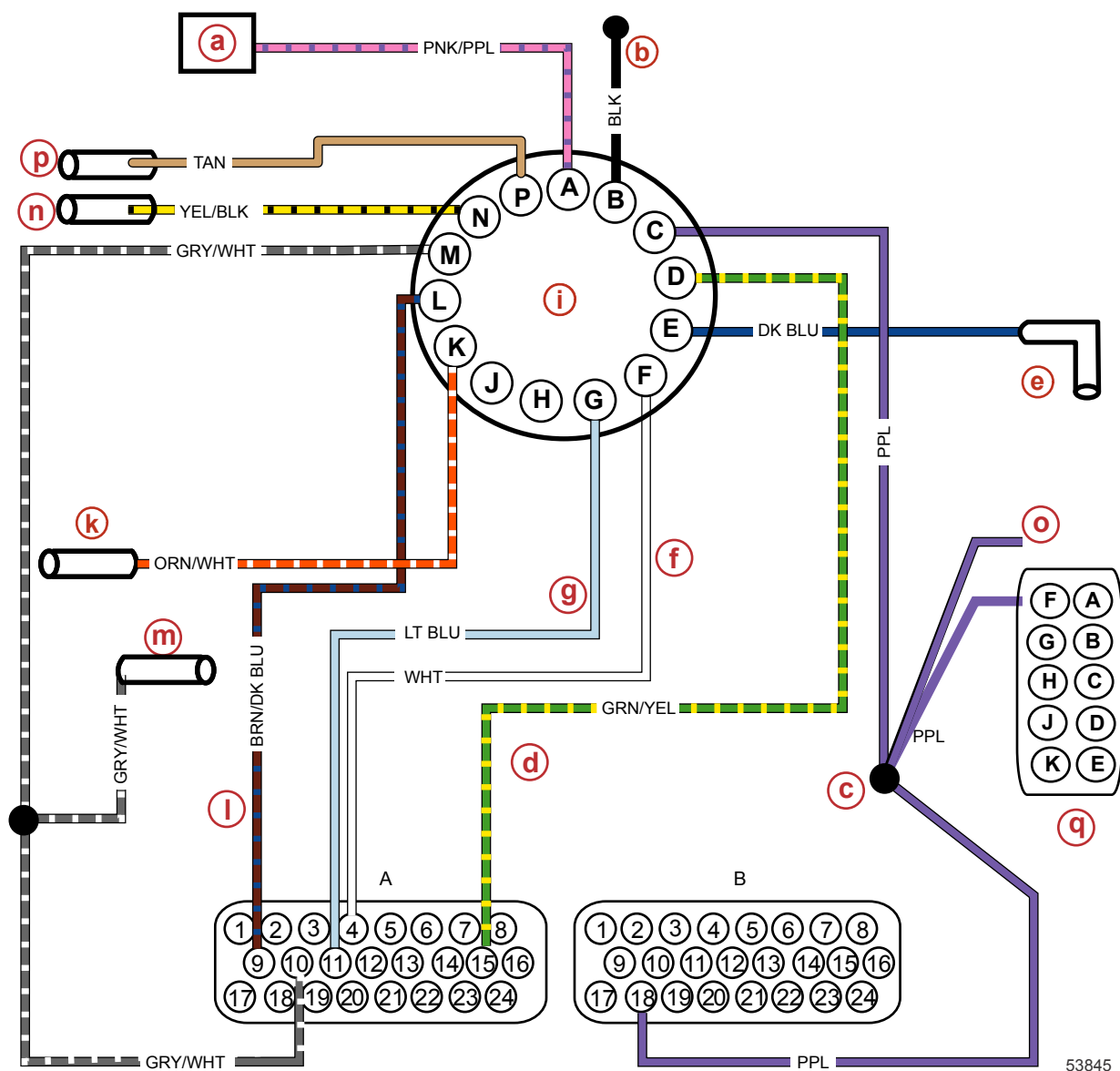
B



17597

Pin	ECM 555SD	4.3 MPI Sterndrive	Pin	ECM 555SD	4.3 MPI Sterndrive
A1	Empty	Empty	B1	Sender ground	Black/pink
A2	Fuel injector bank 2	Lt green/white	B2	MAT signal	Tan/yellow
A3	Empty	Empty	B3	MAP signal	Lt green
A4	CAN 1 (+)	White	B4	Fuel level 1 signal	Pink/black
A5	Scan (-)	White/purple	B5	Empty	Empty
A6	Empty	Empty	B6	Empty	Empty
A7	Empty	Empty	B7	Oil pressure signal	Dk blue/black
A8	Trans temp/lube bottle	Dk blue/brown	B8	Steering angle signal	Pink/dk blue
A9	Warning horn	Brown/dk blue	B9	Paddle wheel signal	Yellow/gray
A10	Tach signal out	Gray/white	B10	CPS signal	Tan/black
A11	CAN 1 (-)	Lt blue	B11	Sea pump signal	Dk blue/white
A12	Scan (+)	White/black	B12	Pilot signal	White/dk blue
A13	Empty	Empty	B13	Digital trim signal	Orange/lit blue
A14	Empty	Empty	B14	ECT signal	Yellow
A15	E-stop (through CAN)	Green/yellow	B15	Empty	Empty
A16	Ground	Black	B16	Empty	Empty
A17	Fuel injector Bank 1	Lt green/purple	B17	Empty	Empty
A18	Empty	Empty	B18	Wake circuit	Purple
A19	Fuel pump Relay Control	Dk green	B19	Shift interrupt signal	Yellow/purple
A20	IAC valve control	Black/dk green	B20	TPS signal	Dk blue/orange
A21	Gear position switch	Yellow/pin	B21	Sender power	Gray
A22	MPR control	Purple/dk green	B22	Sea temp signal	White/yellow
A23	MPR output (to ECM)	PNK	B23	EST (coil control)	White/dk green
A24	Ground	BLK	B24	Empty	Empty

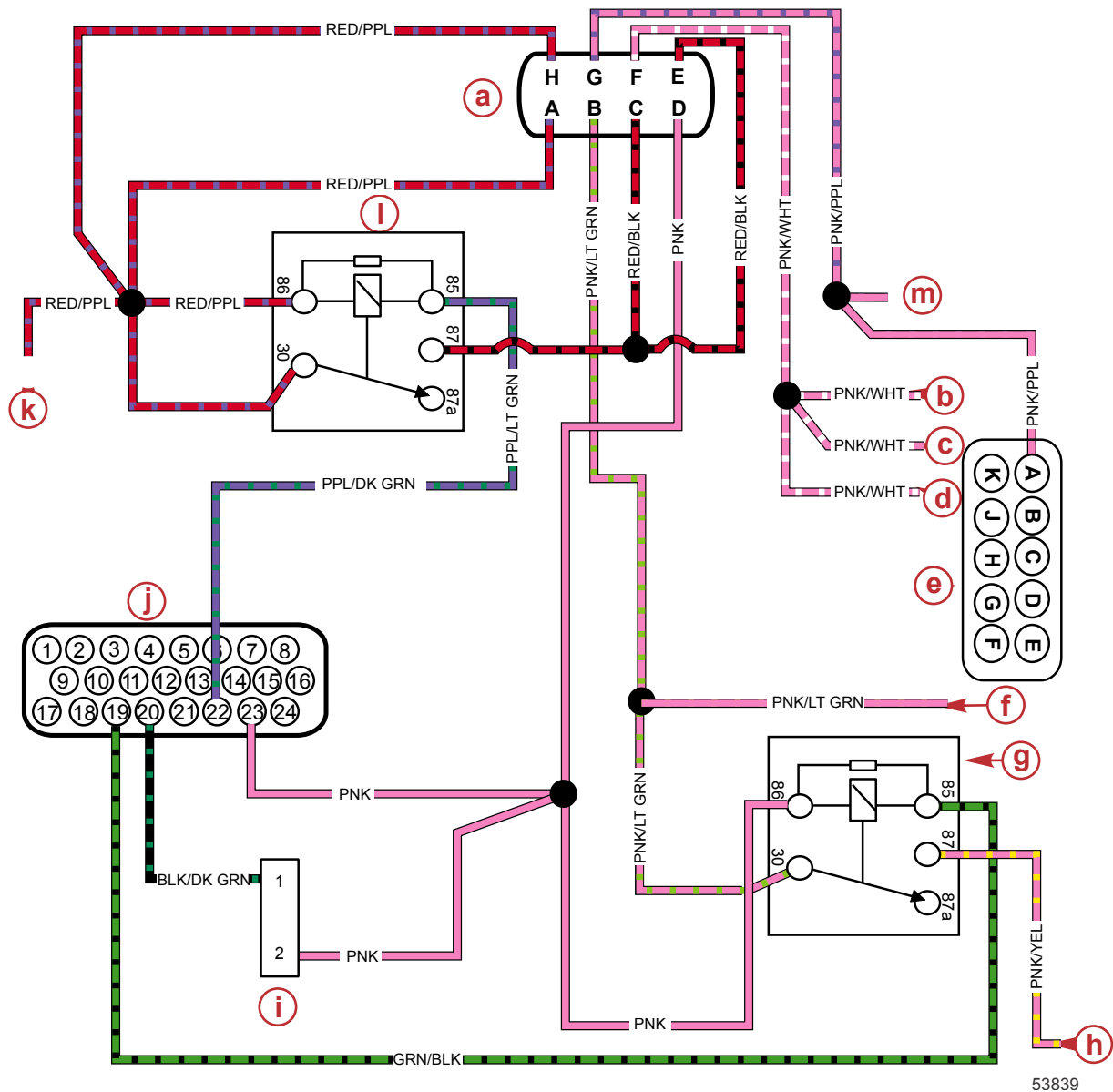
14-Pin Connection Circuits



53845

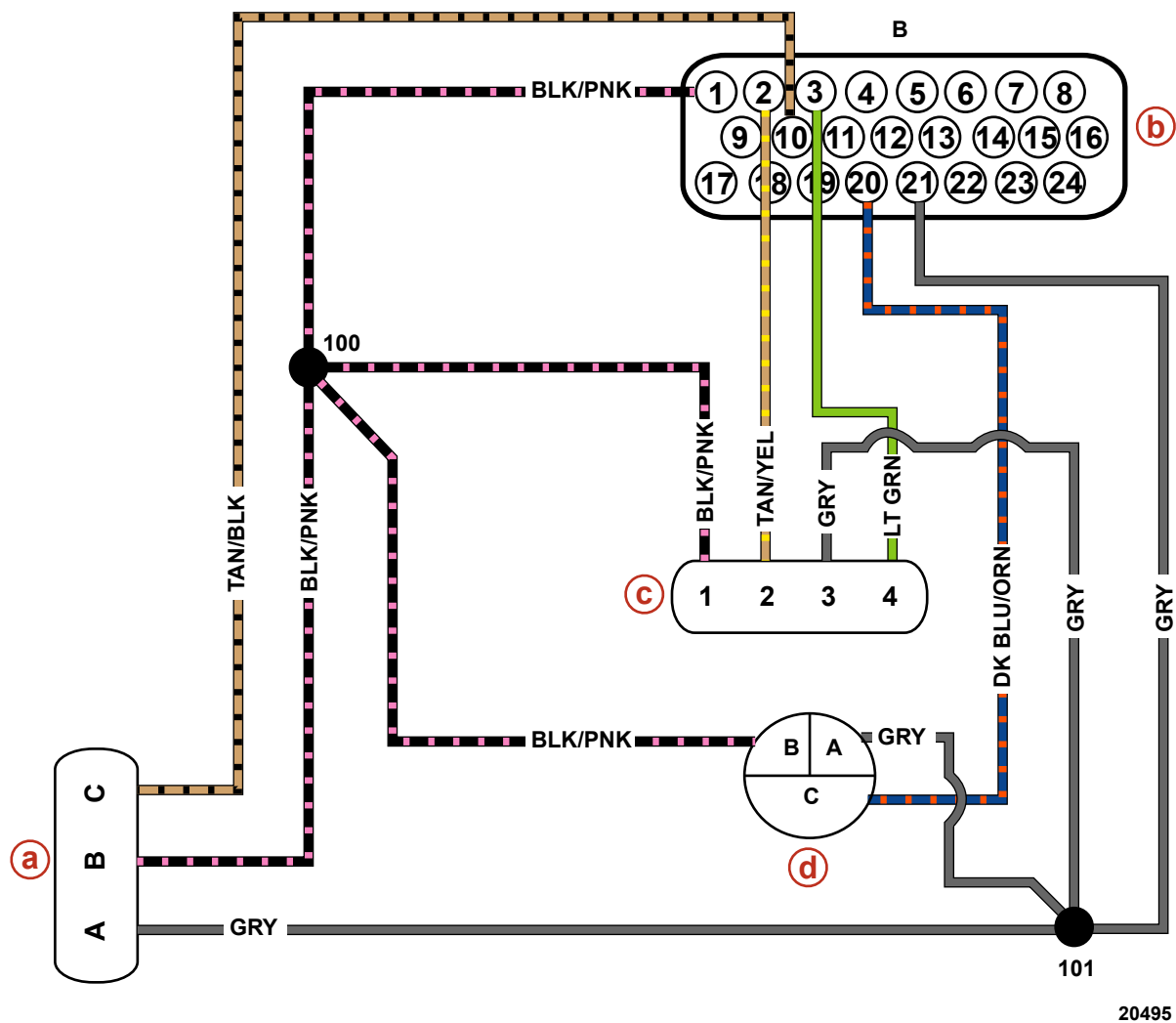
- a - Fuse block
- b - Ground
- c - Wake
- d - E-stop (not used)
- e - Analog oil pressure
- f - CAN P +
- g - CAN P -
- h - Not used
- i - 14-pin connector
- j - Not used
- k - Analog trim
- l - Horn
- m - Tachometer
- n - Cranking
- o - Alternator excitation
- p - Coolant temperature
- q - CAN connector

Fuses, IAC, and Relays 14-Pin



- a** - Fuse holder
- b** - To fuel injectors
- c** - To pin A of ignition coil
- d** - To pin A of coil driver
- e** - Pin A of CAN connector
- f** - To alternator pin B sensing wire
- g** - Fuel pump relay
- h** - Cool fuel pump
- i** - IAC valve connector
- j** - ECM connector A
- k** - To 50-amp circuit breaker
- l** - Main power relay (MPR)
- m** - To pin A of 14 pin

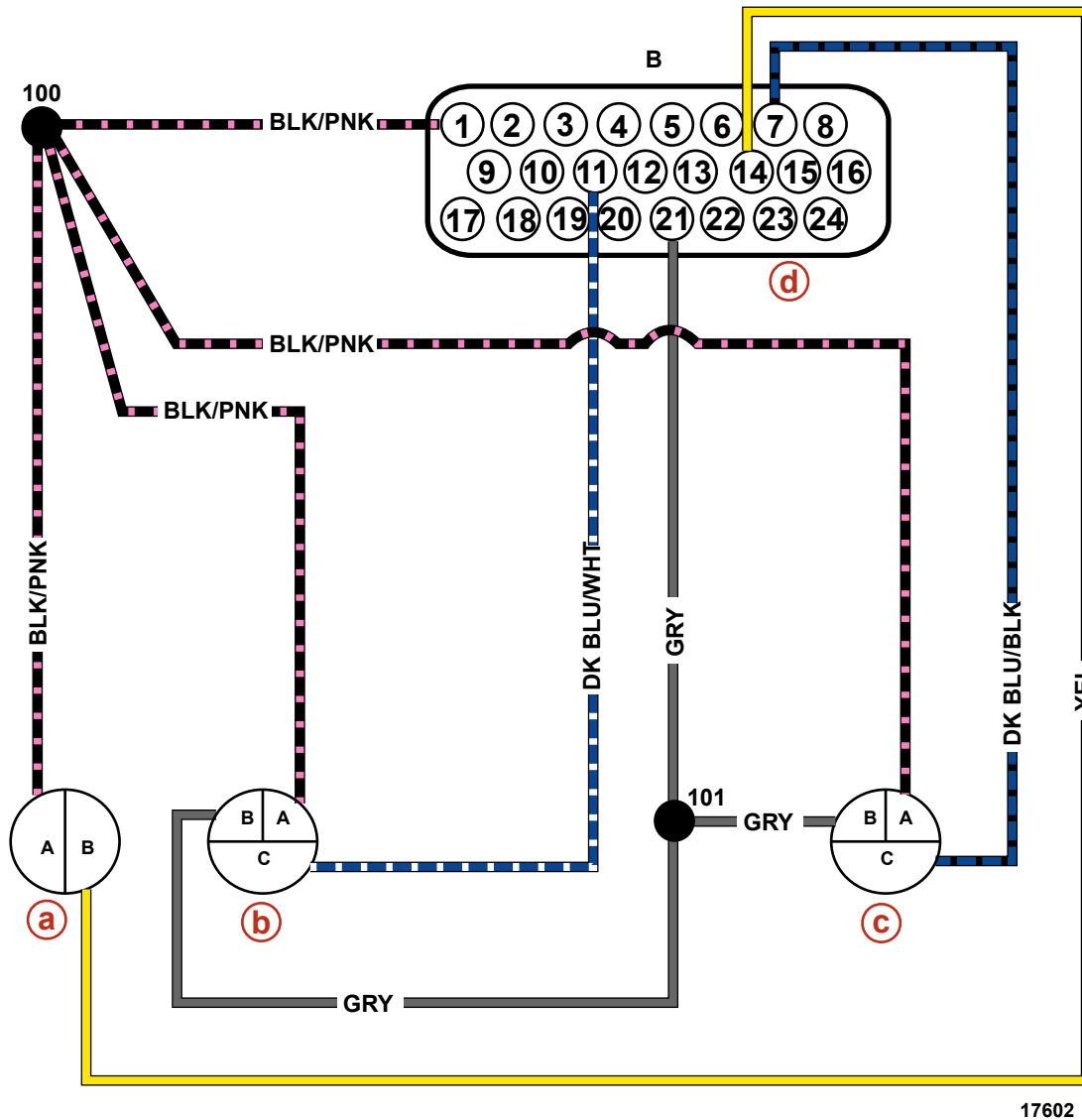
Manifold Air Pressure and Temperature, Crankshaft Position, and Throttle Position Sensors, Without Camshaft Position Sensor



20495

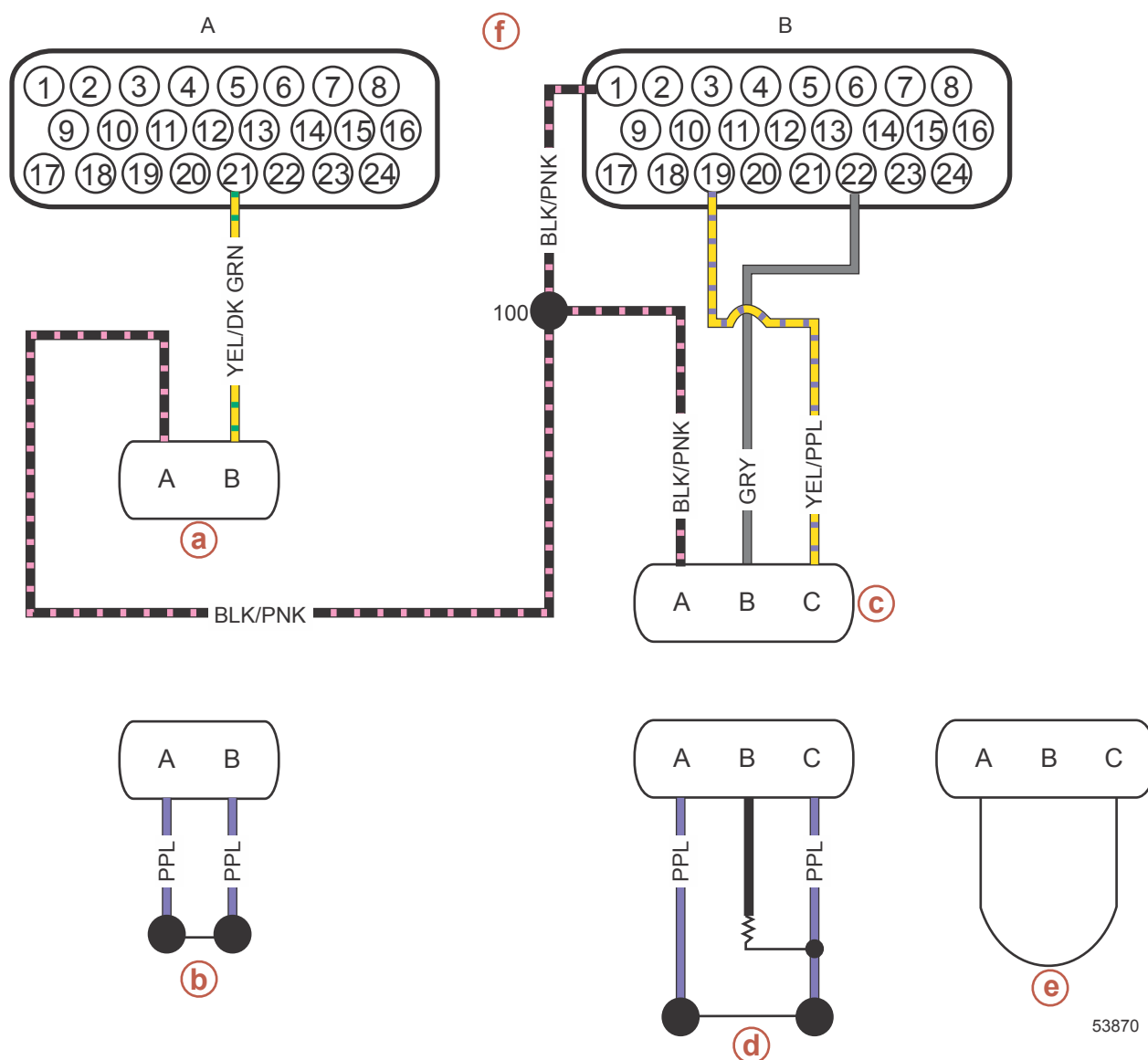
- a -** Crankshaft position sensor
- b -** ECM 555 connector B
- c -** Manifold air pressure and manifold air temperature
- d -** Throttle position sender

Engine Coolant Temperature, Seawater Pump and Oil Pressure Sensors



- a** - Engine coolant temperature
- b** - Seawater pump pressure
- c** - Oil pressure
- d** - ECM 555 connector B

Gear Indicator and Shift Interrupt

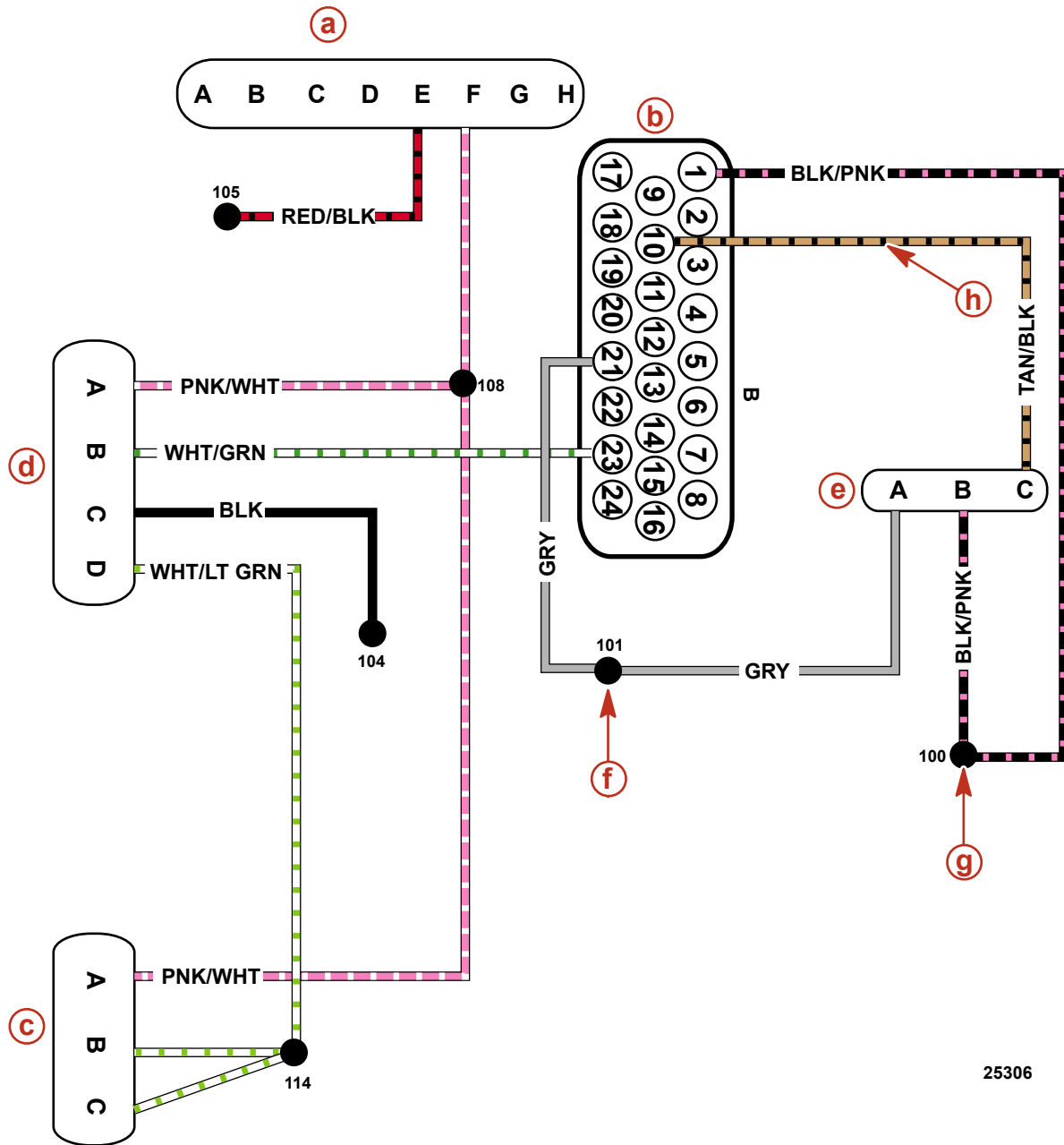


- a** - Gear indicator connector
- b** - Gear indicator switch
- c** - Shift interrupt switch connector
- d** - Shift interrupt switch
- e** - Jumper plug (Bravo models)
- f** - ECM 555 connectors A and B

The gear indicator switch used on 4.3L MPI Alpha and Bravo models is a normally closed switch (in neutral position) and opens when the shift bracket is in the forward or reverse gear position.

The shift interrupt switch used on 4.3L MPI Alpha models is a normally closed switch (in neutral position) and is momentarily opened when shifting in-or-out of gear.

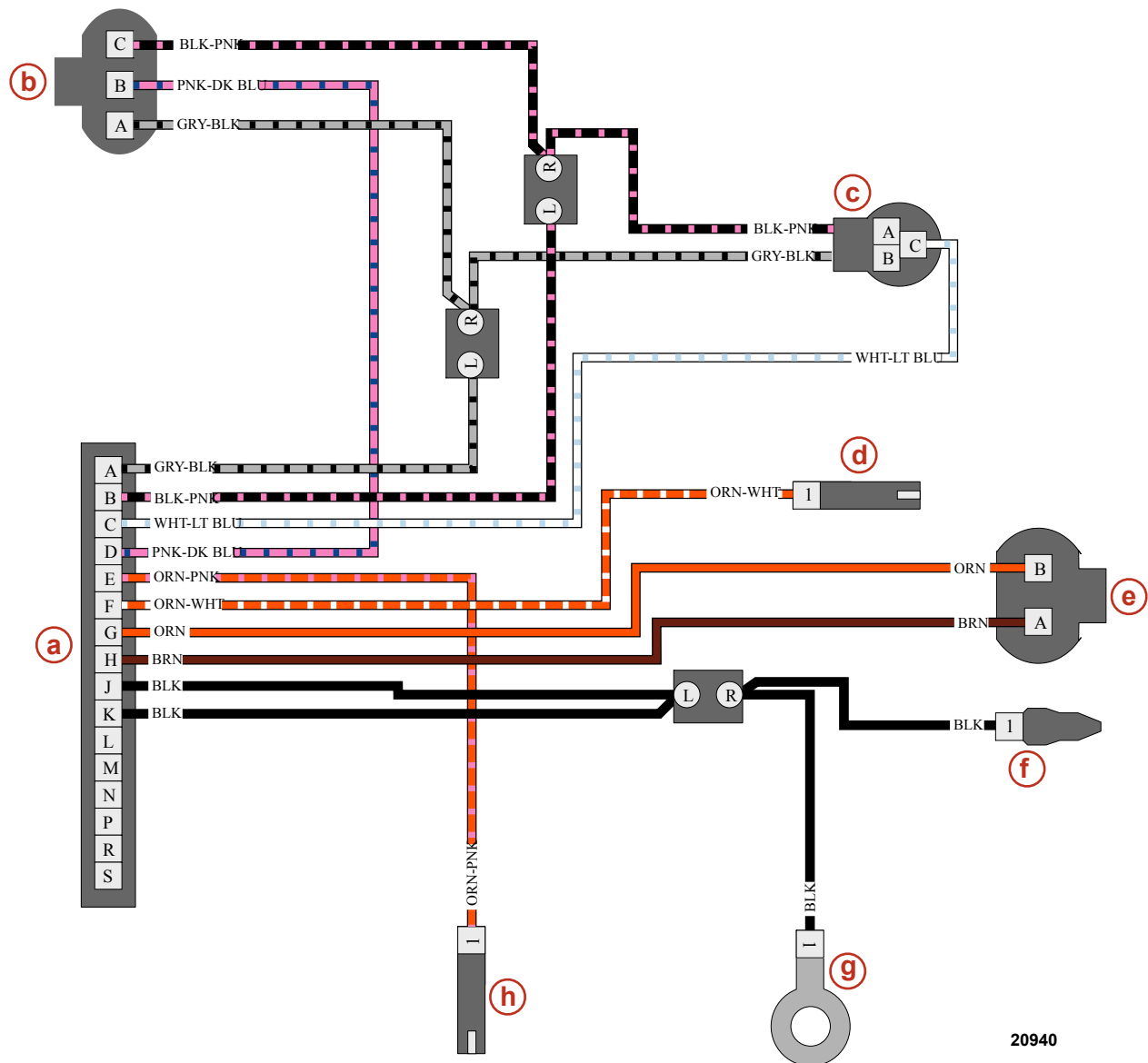
Ignition System without Camshaft Position Sensor



25306

- a** - Fuse holder
- b** - ECM 555 connector B
- c** - Ignition coil
- d** - Ignition coil driver module
- e** - CPS connector
- f** - 5-volt power
- g** - 5-volt ground
- h** - CPS signal

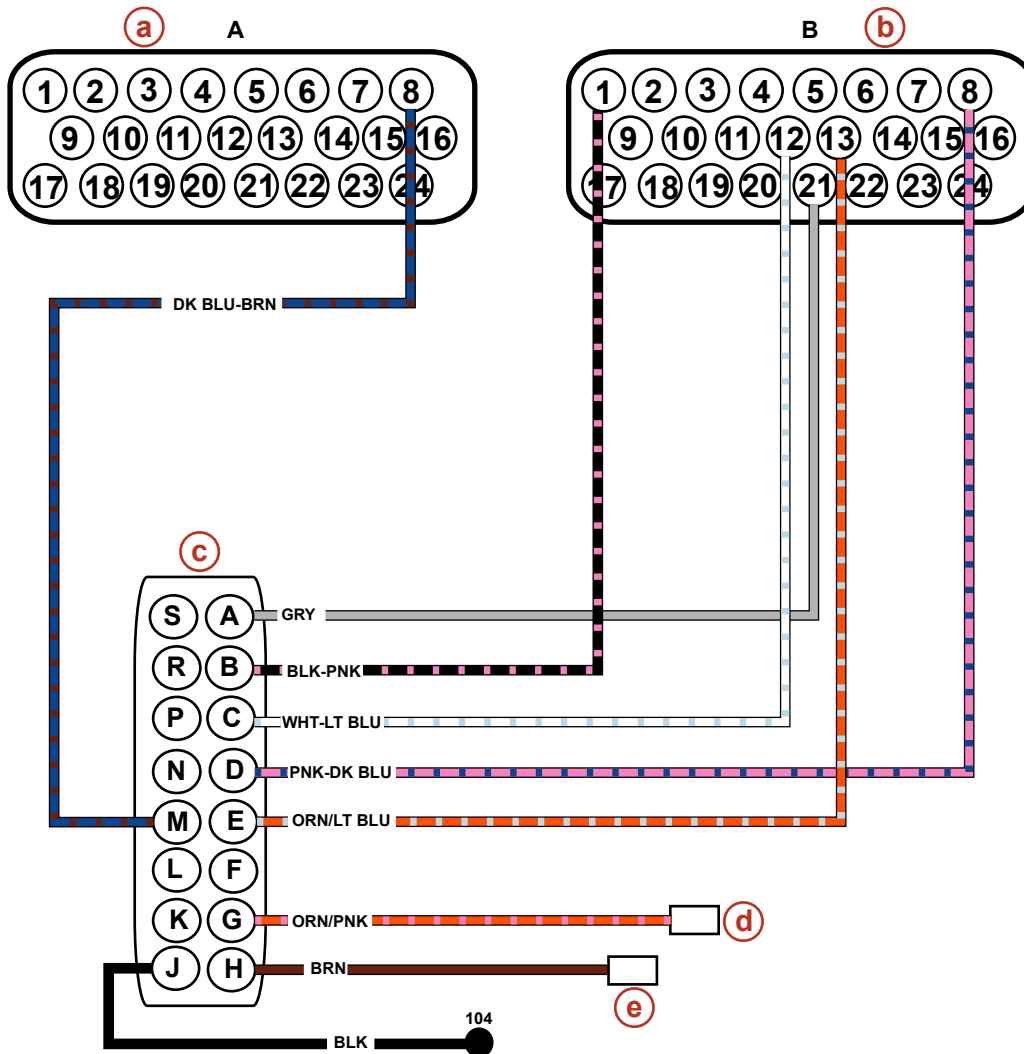
Transom Harness Connector (to Sterndrive)



20940

- a** - 16-pin transom harness connector
- b** - Steering
- c** - Pitot
- d** - Analog trim
- e** - MerCathode connector
- f** - Analog and digital trim ground
- g** - Ground
- h** - Digital trim

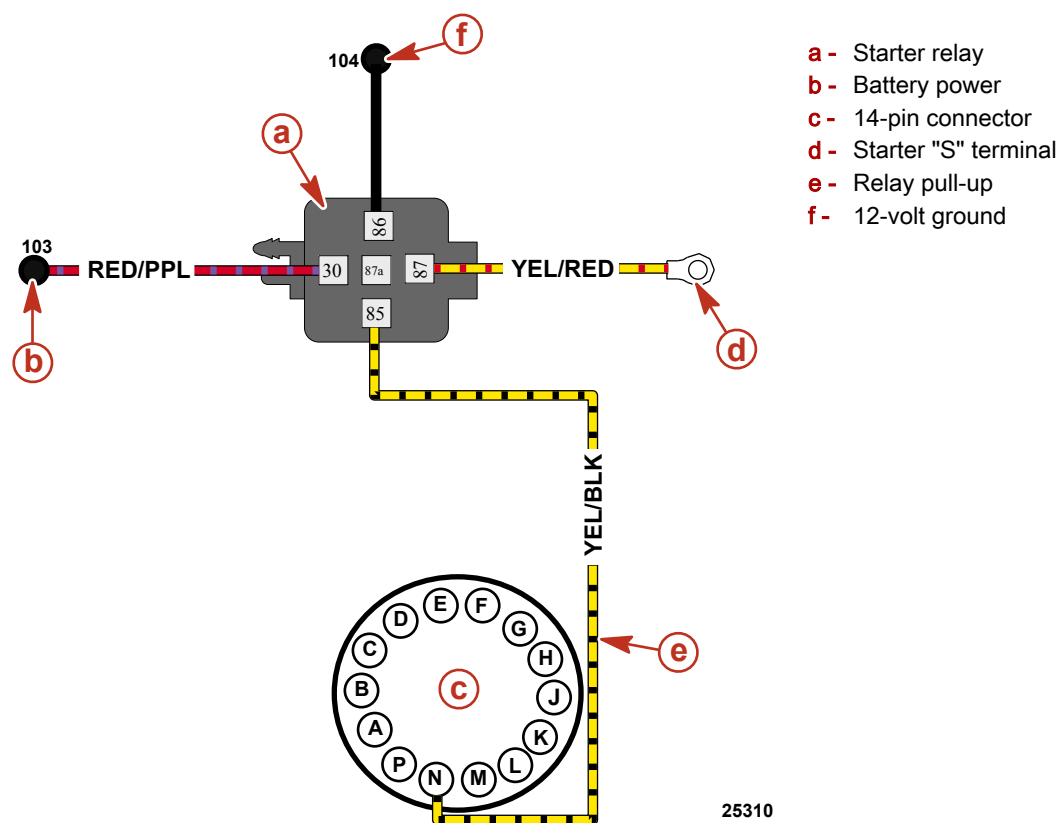
Transom Harness Connector (to Engine)



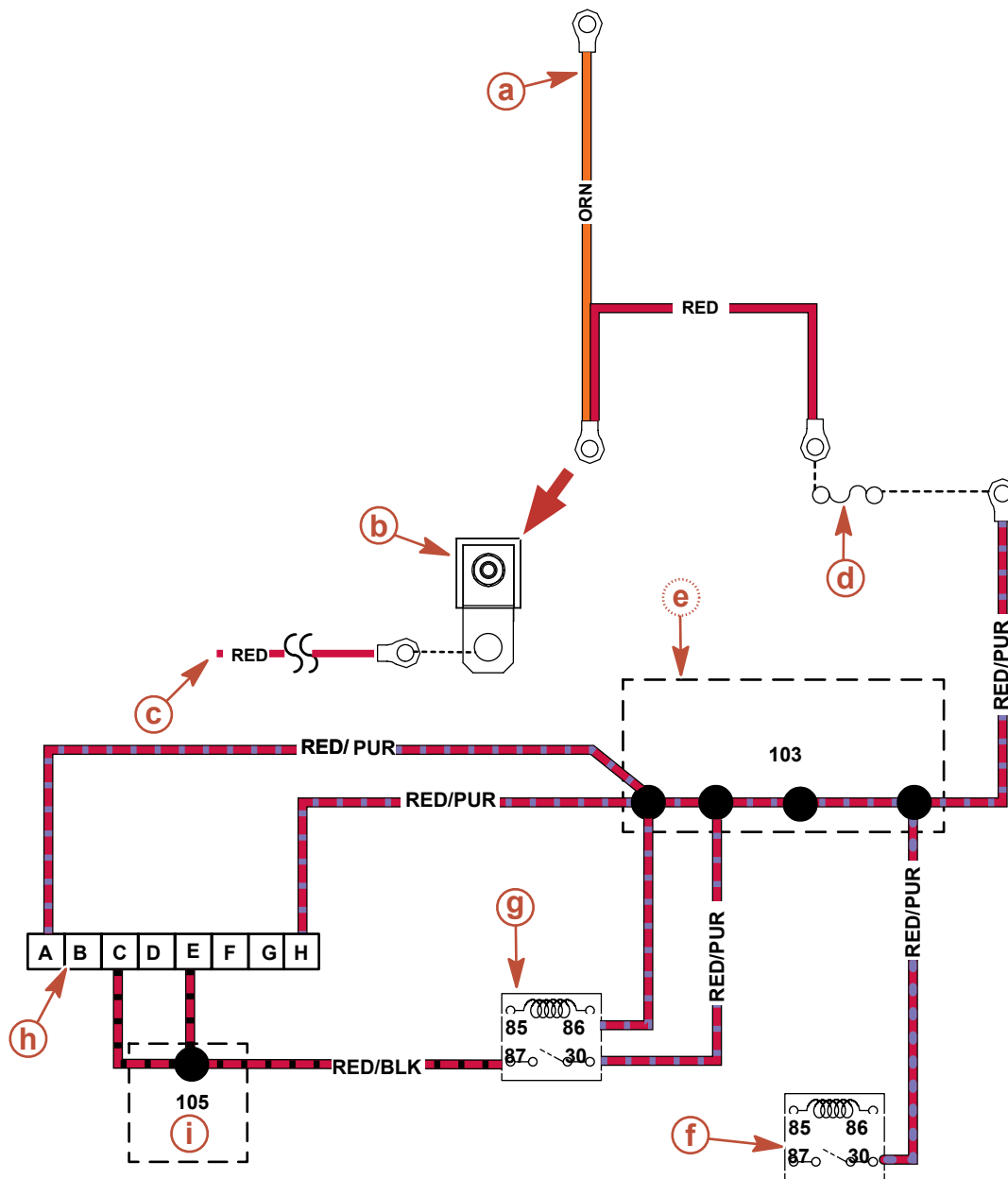
26026

- a - ECM 555 connector A
- b - ECM 555 connector B
- c - 16-pin connector
- d - MerCathode anode
- e - MerCathode electrode

Starter Relay Circuit—Sterndrive



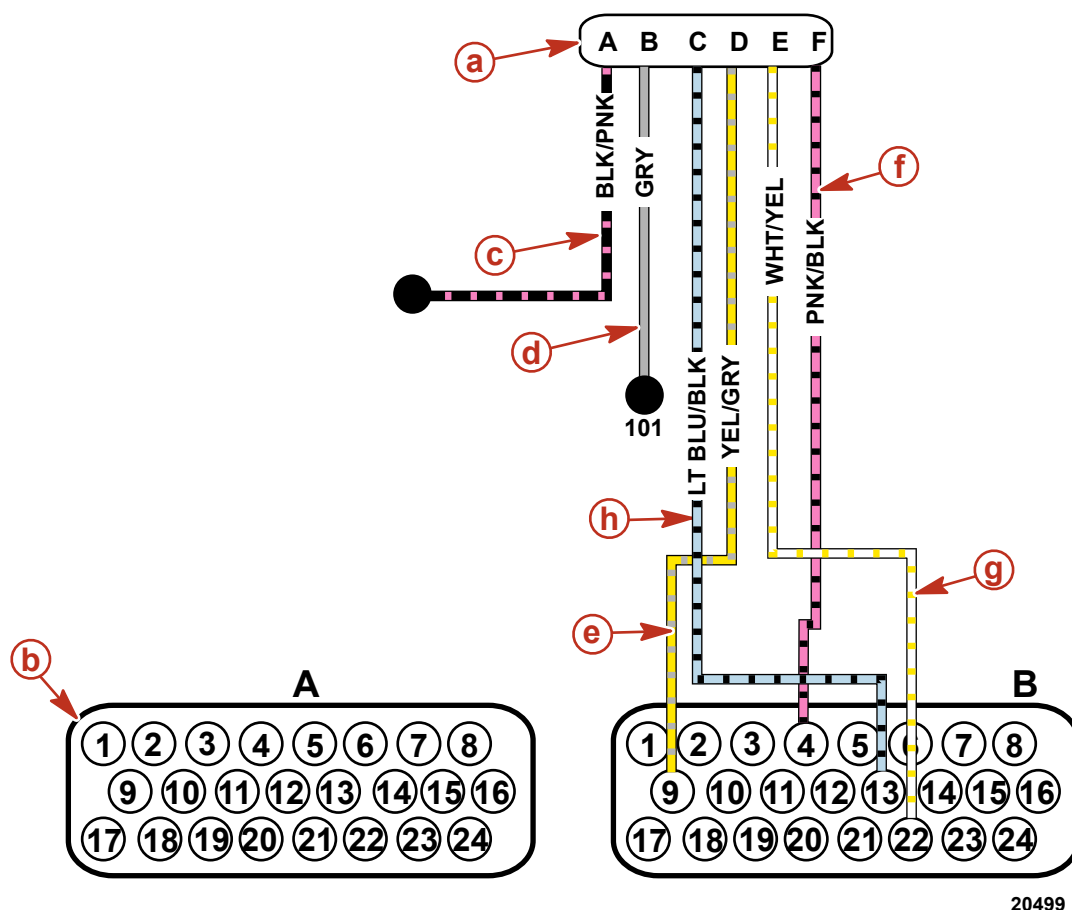
Alternator Output Circuit



25313

- a** - From alternator
- b** - Fuse on starter
- c** - To battery
- d** - 50-amp circuit breaker
- e** - Splice 103
- f** - Starter relay
- g** - Main power relay
- h** - Fuses
- i** - Splice 105

Harness To Paddle Wheel Connector and Fuel Level Circuits



20499

- a** - Paddle wheel connector
- b** - ECM 555 connectors A and B
- c** - 5-volt ground
- d** - 5-volt power
- e** - Paddle wheel
- f** - Fuel level 1 signal
- g** - Seawater temperature
- h** - Fuel level 2 signal

The paddle wheel circuit supplies the ECM with boat speed and seawater temperature readings. The paddle wheel is much more precise than the pitot circuit at lower speeds. The connector is located on the rear of the engine.

A malfunction in the paddle wheel circuit will not set a fault.

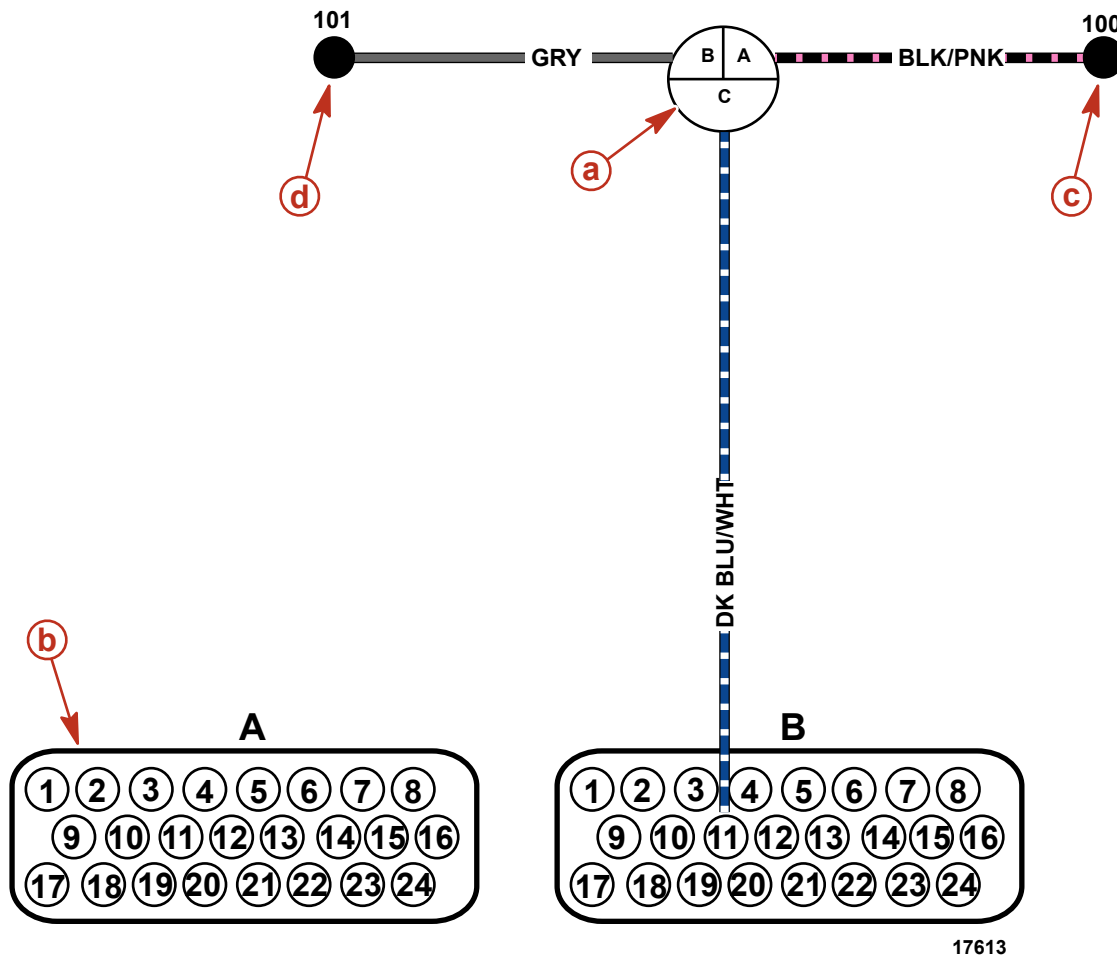
The fuel level sensor circuit supplies the ECM with a signal for the fuel level. The 6-pin connector is located at the rear of the engine or on top.

A malfunction in the fuel level circuit will set a fault code.

Single Circuit Diagrams

This section outlines the circuitry, the wiring harness, and sensors as individual systems. This allows for a quick reference point when trying to detect a faulty connection. However, the complete system wiring diagram should be referenced if multiple electrical faults are occurring.

Seawater Pump Circuit

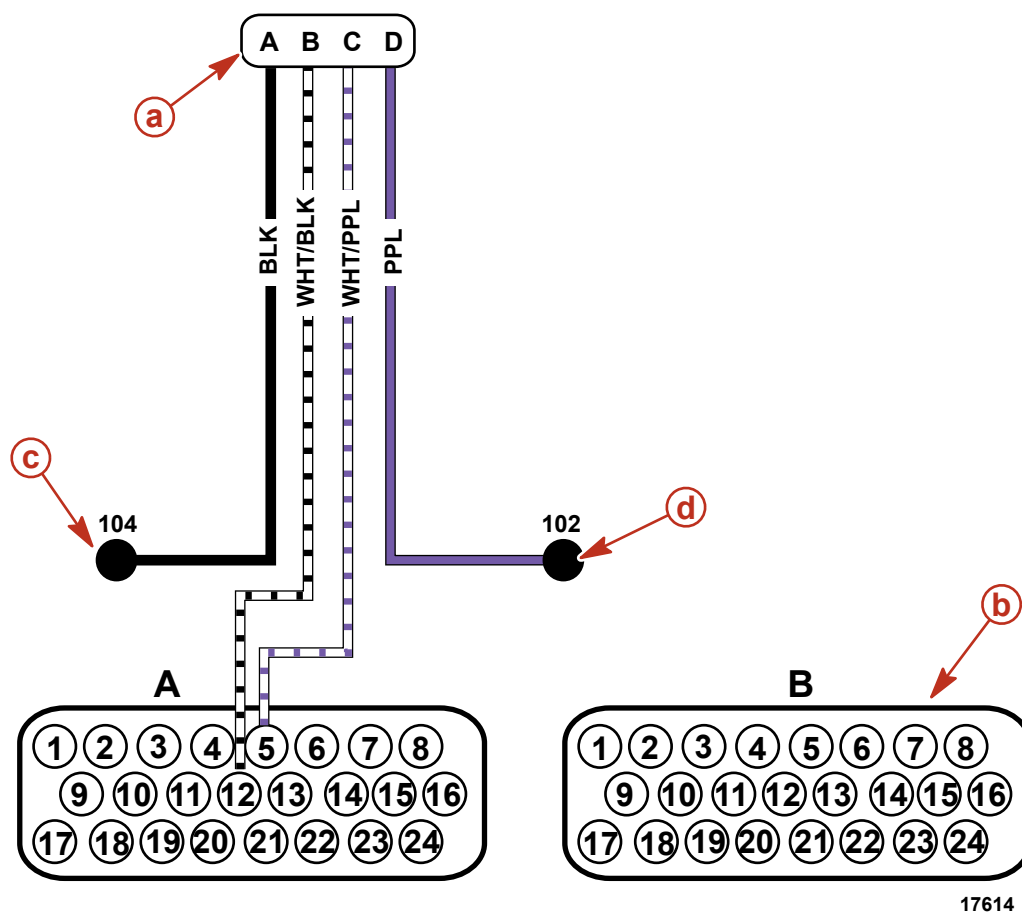


- a** - Seawater pump sensor connector
- b** - ECM
- c** - 5-volt ground
- d** - 5-volt power

Seawater pump pressure sensor and water inlet pressure specifications are in the ECM Diagnostics Systems Information file. To check if the sensor is within range, the diagnostic tool reading with key on should be approximately 0.

A malfunction of the seawater pump sensor will set the fault of Seapump CKT Hi, Seapump CKT Lo, or Seapump PSI Lo.

Diagnostics Circuit



- a** - Diagnostic connector
- b** - ECM connectors A and B
- c** - 12-volt ground
- d** - 12-volt power

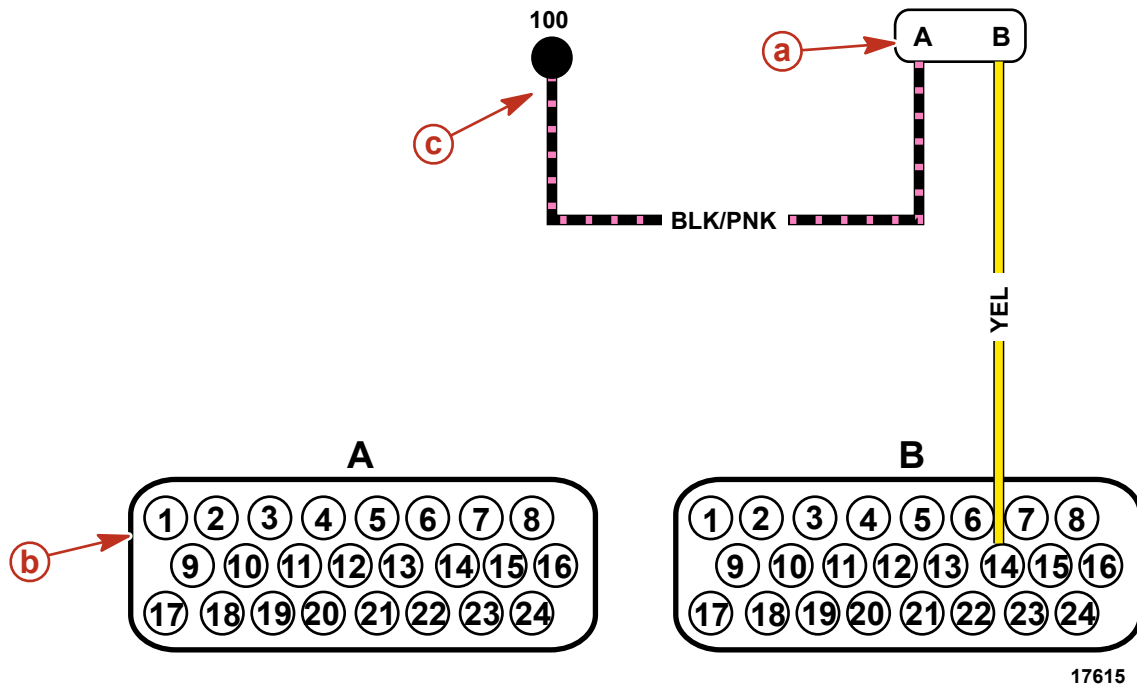
The data link connector (DLC) is a 4-pin circuit for attaching the diagnostic tool to the ECM. The DLC is located on the top of the engine and is labeled "DIAGS/DEPTH FINDER." Before attaching a diagnostic tool to the engine, verify that the key is off and the pins are clean of corrosion and debris. Pin A is the 12-volt ground connected to the engine harness at splice 104. Pins B and C are data retrieval lines from the ECM. Pin D is the 12-volt supply to the diagnostic tool.

Computer Diagnostic System (CDS)	Available through Bosch Automotive Service Solutions
----------------------------------	--

IMPORTANT: Diagnostic tools can only receive data with the key on or engine operating. Diagnostic tools need a minimum of 9.5 volts. If the diagnostic tool does not respond, verify the connection, verify that the key is on, and check the battery voltage.

A malfunction of the data link connector will not set a fault.

Engine Coolant Temperature Circuit



- a - ECT sensor connector
- b - ECM
- c - 5-volt ground

The engine coolant temperature (ECT) sensor is a thermistor immersed in the engine coolant stream. The ECT is located in the thermostat housing of the engine. Low coolant temperature produces high resistance, while high temperature causes low resistance.

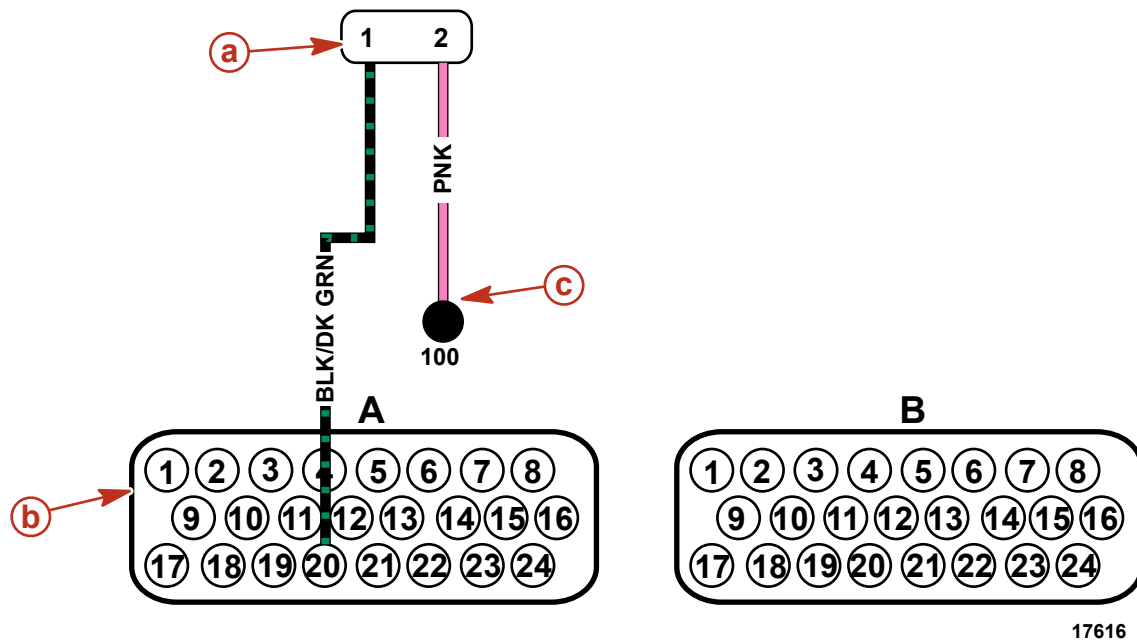
A malfunction of the ECT sensor will set a fault of ECT CKT Hi, ECT CKT Lo, or ECT Coolant Overheat.

Approximate Temperature-to-Resistance Values		
Degrees ° F	Degrees ° C	Ohms Ω
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

NOTE: Resistance values are approximate. Readings taken with a DVOM must be within plus-minus (±) 10 ohms of specification.

DMT 2004 Digital Multimeter	91-892647A01
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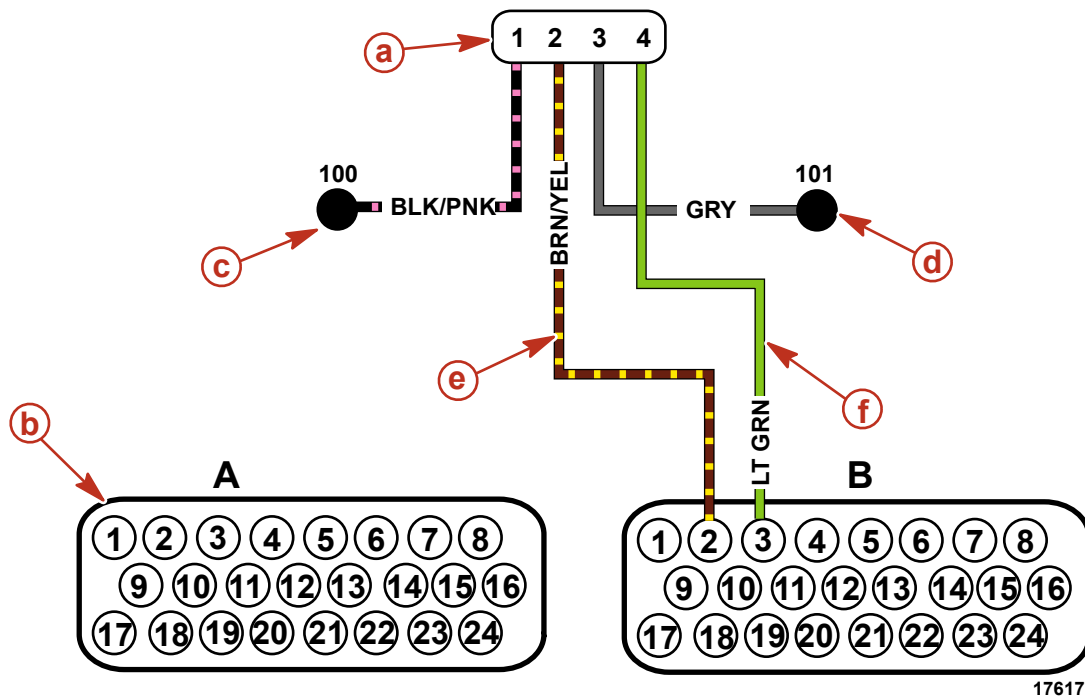
IAC Circuit



- a** - IAC sensor connector
- b** - ECM connector A and B
- c** - 12-volt key power

The idle air control (IAC) valve is a 12-volt circuit powered by the MPR. The IAC is mounted on the throttle body. A malfunction of the IAC will set a fault of IAC Output.

MAPT Circuit



- a** - MAPT sensor connector
- b** - ECM connector A and B
- c** - 5-volt ground
- d** - 5-volt power
- e** - MAT signal
- f** - MAP signal

The MAPT sensor uses two circuits to measure manifold air temperature (MAT) and manifold absolute pressure (MAP).

MAT Circuit

The MAT portion of the sensor uses a thermistor to control signal voltage to the ECM. When intake air is cold, the sensor resistance is high. As intake air warms, sensor resistance drops.

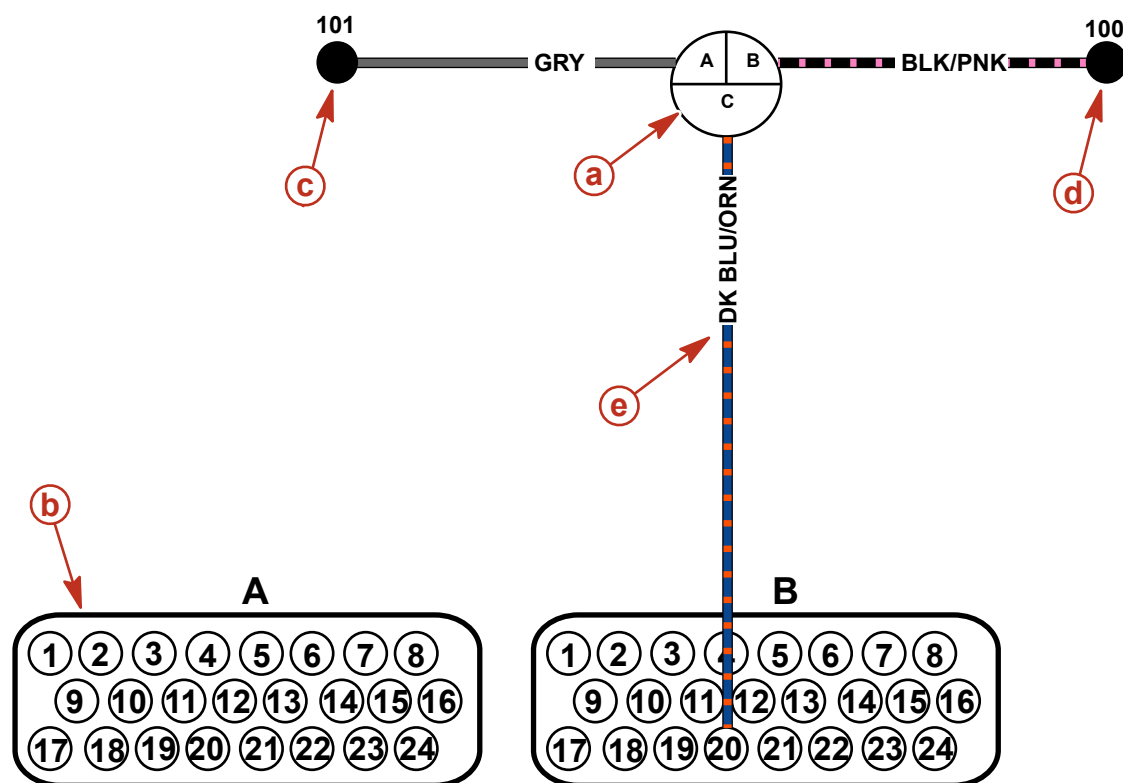
A malfunction in the MAT will set the fault of AIR TMP CKT Hi or AIR TMP CKT Lo.

MAP Circuit

The MAP portion of the sensor measures changes in intake manifold pressure. At key on, the MAP is equal to atmospheric pressure. This information is used by the ECM as an indication of altitude and is recorded as BARO. Comparison of this BARO reading with a known good MAP sensor is a good check of a suspect sensor. The pressure changes as a result of engine load and speed change. The ECM receives this information as a signal voltage that will vary from less than 2.0 volts at idle to 4.0 or 5.0 volts at WOT.

A malfunction in the MAP sensor circuit sets the fault of MAP Sensor Input HI or MAP Sensor Input Lo.

Throttle Position Circuit



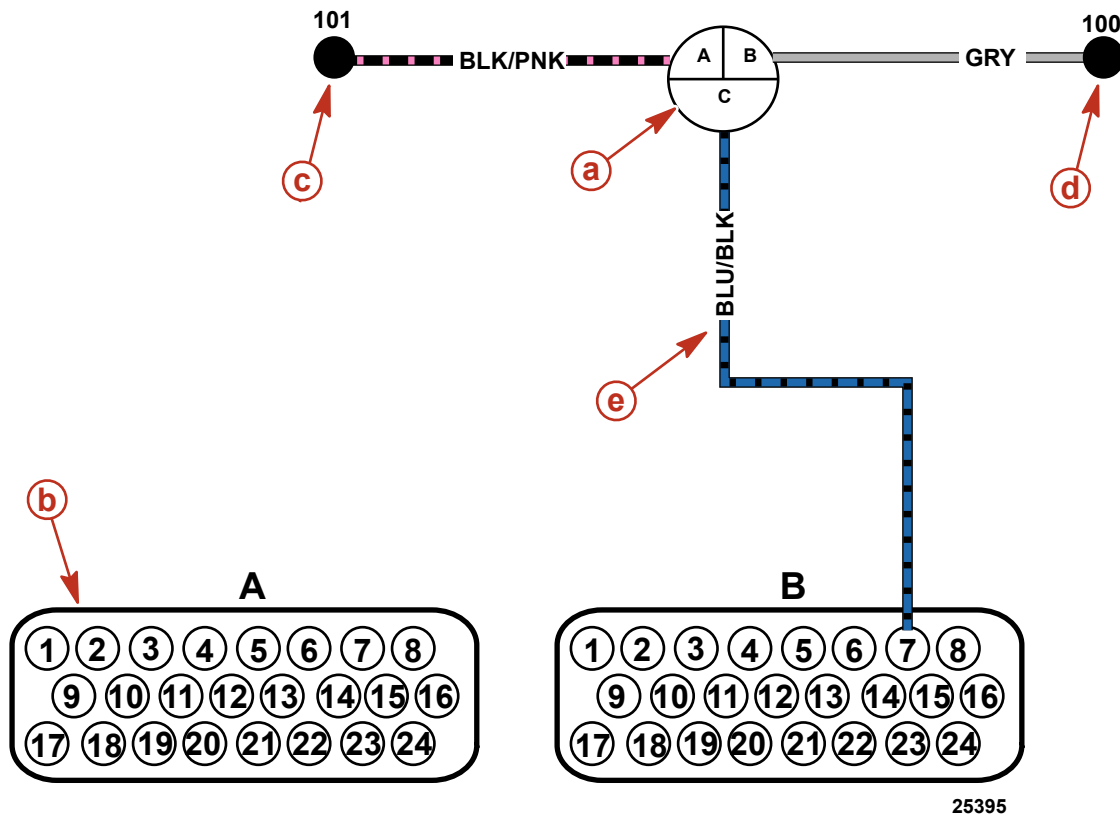
17618

- a** - TPS connector
- b** - ECM connector A and B
- c** - 5-volt power
- d** - 5-volt ground
- e** - TPS signal

The throttle position sensor (TPS) sends throttle plate angle information to the ECM. The TPS is located on the throttle body. Signal voltage should vary from 0.5 volts at idle to 4.8 volts at WOT, although these numbers can vary by model. If the TPS malfunctions, the ECM will reset to a default value.

A malfunction in the TPS circuit sets the fault of TPS Input Hi, TPS Input Lo, TPS Range Hi, TPS Range Lo, or TPS No Adapt.

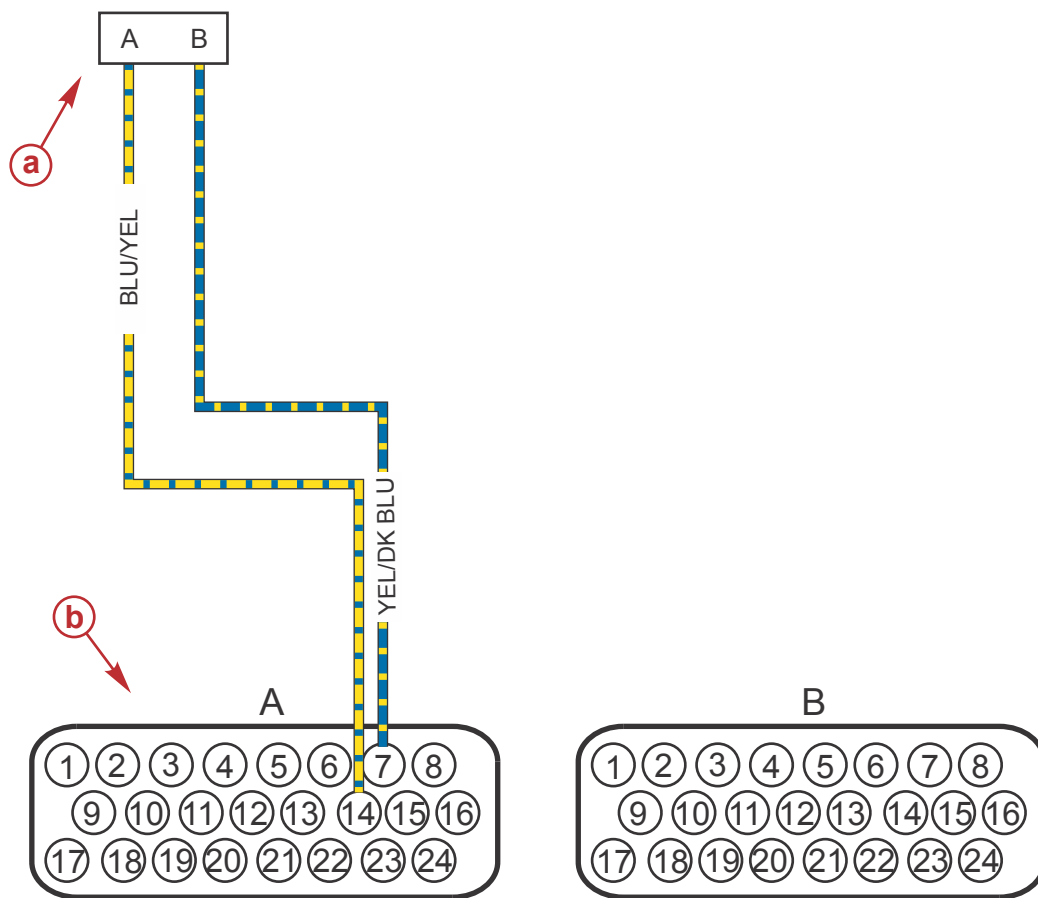
Oil Pressure Circuit



- a** - Oil pressure sensor connector
- b** - ECM connector A and B
- c** - 5-volt ground
- d** - 5-volt power
- e** - Signal

The oil pressure sensor measures oil flow through the oil galleries. It is located on the rear port side of the engine. A malfunction of the oil pressure sensor sets the fault Oil PSI CKT Hi, Oil PSI CKT Lo, or Oil PSI Lo.

Knock Sensor



53882

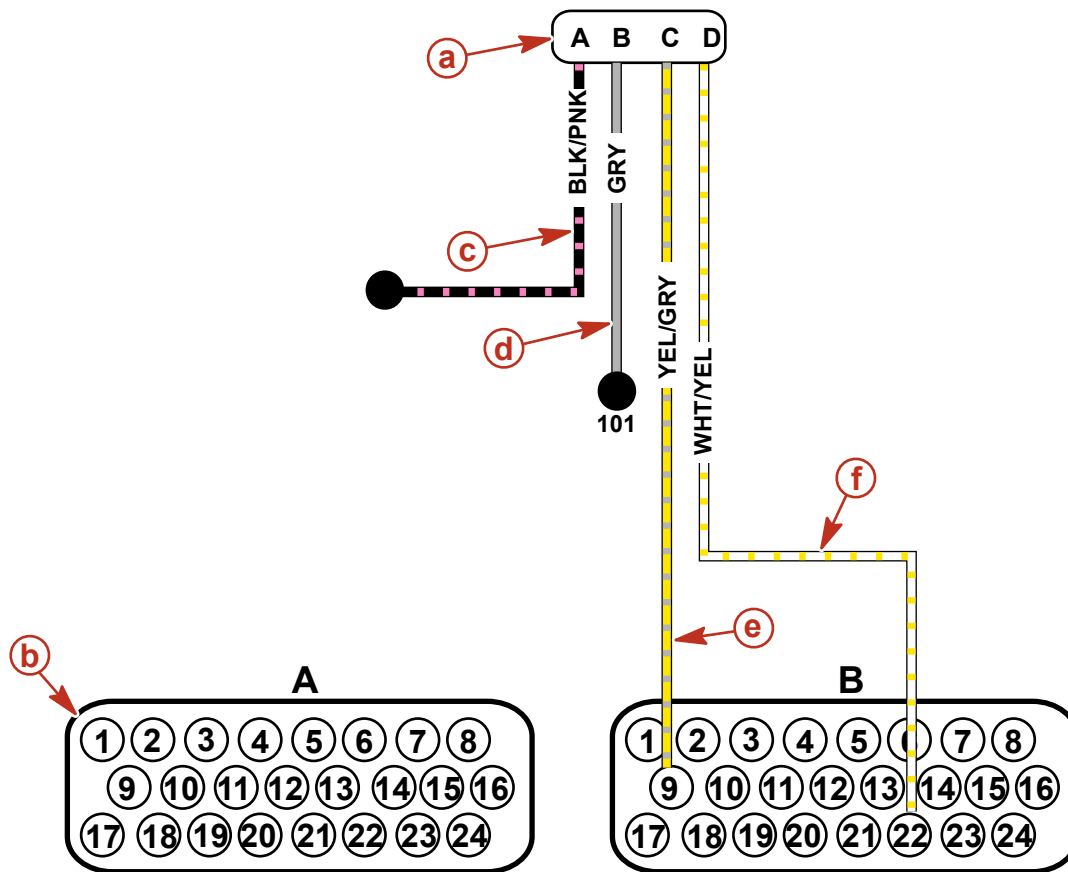
- a** - Knock sensor
- b** - ECM connector A

NOTE: 4.3L MPI engines manufactured from engine serial number 0W650000 and above are not equipped with knock sensors.

The knock sensor detects engine detonation, or spark knock, and sends a voltage signal to the ECM. It is located on the lower half of the engine on the port side near the oil sending transducer. As the sensor detects knock, the voltage output level increases and informs the ECM of the problem.

NOTE: The knock sensor is located on the rear, port-side of the engine above the flywheel housing.

Paddle Wheel Connector Circuit—All Engines



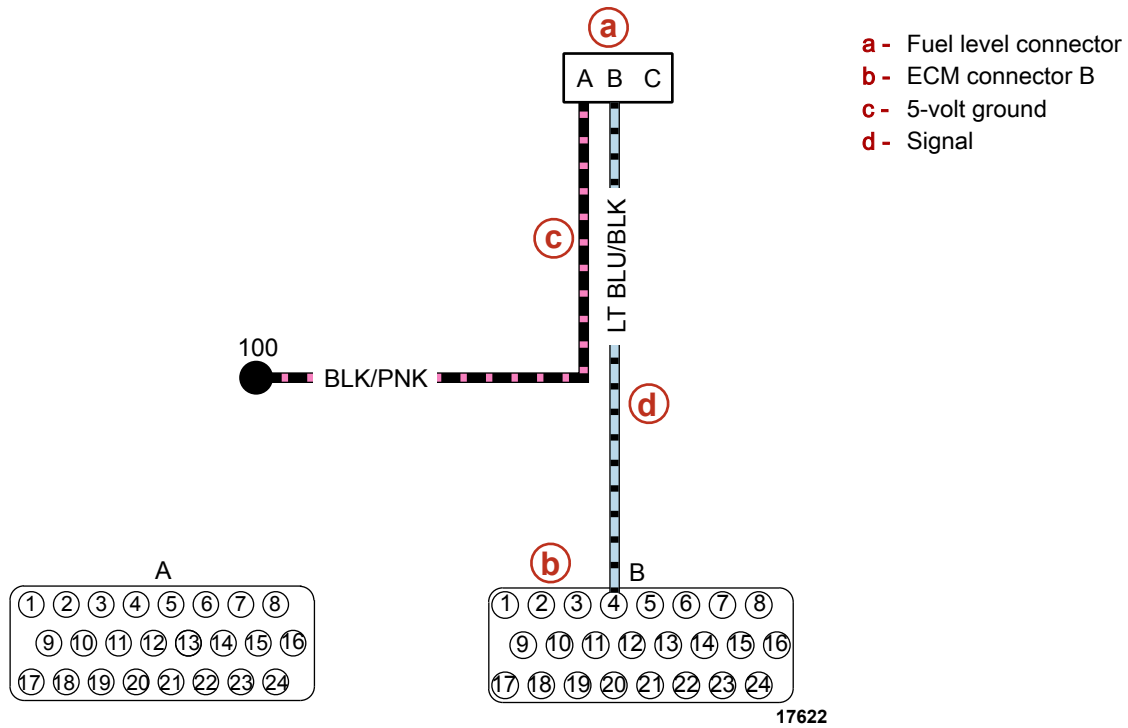
25752

- a** - Paddle wheel connector
- b** - ECM connector A and B
- c** - 5-volt ground
- d** - 5-volt power
- e** - Paddle wheel
- f** - Water temperature

The paddle wheel circuit supplies the ECM with boat speed and seawater temperature readings; it is much more precise than the pitot circuit at lower speeds. The paddle wheel circuit is located on the rear of the engine.

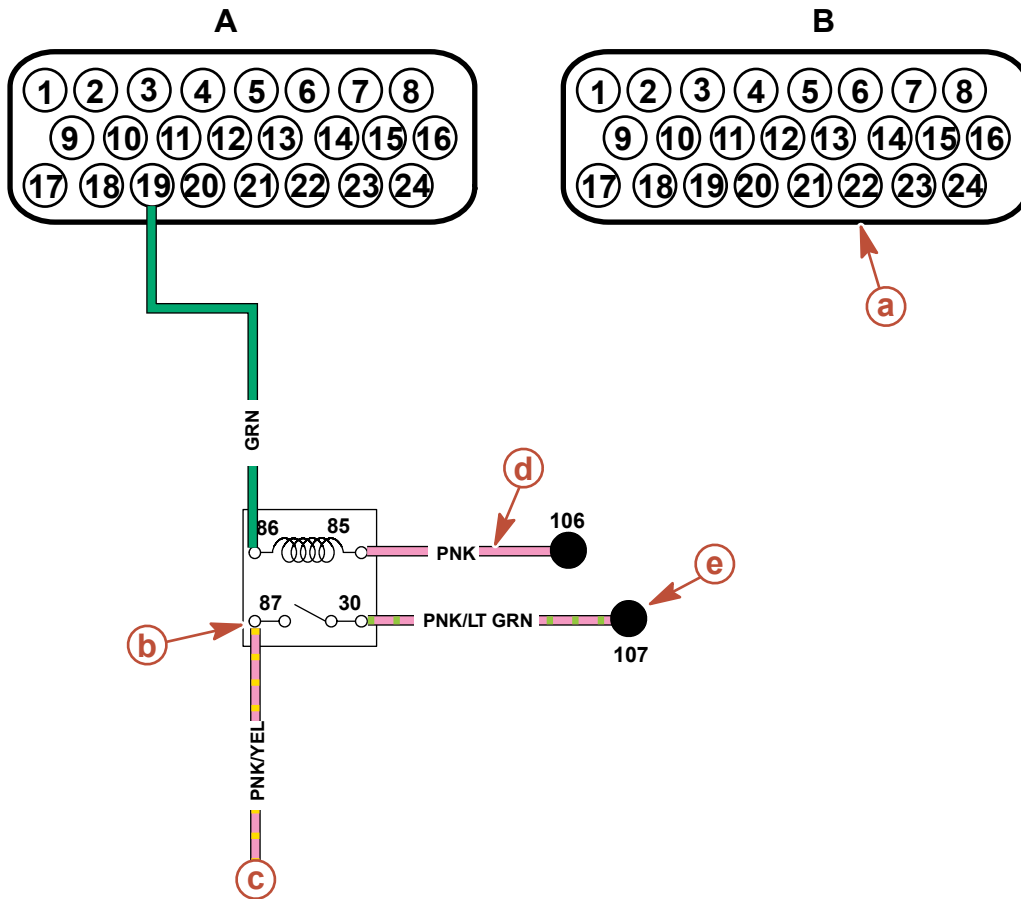
A malfunction in the paddle wheel circuit does not set a fault.

Fuel Level Circuit



The fuel level sensor circuit supplies the ECM with the fuel level. It is located on the port rear of the engine. A malfunction in the fuel level circuit does not set a fault.

Fuel Pump Relay Circuit—All Engines

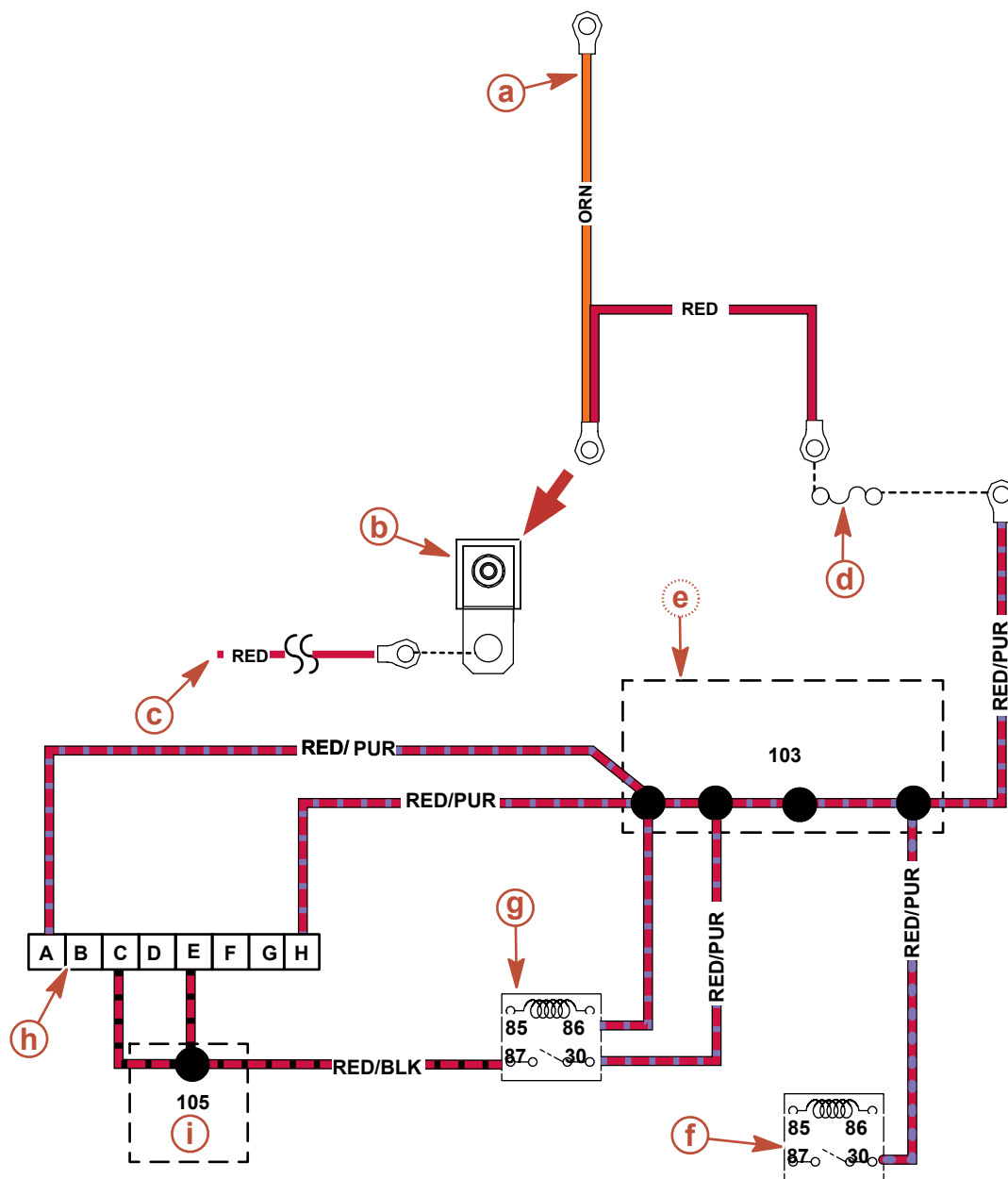


25756

- a** - ECM connectors A and B
- b** - Fuel pump relay
- c** - To fuel pump
- d** - Switched fused 12-volt power
- e** - 12-volt fused power

When the key is turned to the on position the fuel pump relay receives 12-volt battery power through the fuses at terminal 30. The relay powers both fuel pumps and signals the ECM that the engine is ready to start. Listen for both fuel pumps to operate when the key is first turned to the on position.

Alternator Output Circuit—All Models



25313

- a** - From alternator
- b** - Fuse on starter
- c** - To battery
- d** - 50-amp circuit breaker
- e** - Splice 103
- f** - Starter relay
- g** - Main power relay
- h** - Fuses
- i** - Splice 105

Fuel System

Section 5A - TKS Carburetor Disassembly and Repair

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Carburetor Removal and Installation.....	5A-11	Reassembly.....	5A-33

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	TKS module screws	92-809821

Special Tools

Idle Mixture Adjusting Screw	91-866201
 9668	Used to adjust the idle mixture on TKS carburetors
Universal Carburetor Gauge	Obtain locally
	Measure dimensions on a carburetor

TKS Carburetor

Specifications

Gen 1 TKS Carburetors

Engine Model	4.3L
Carburetor number	865941
Float level	14 mm (0.550 in.) (see notes)
Float drop	27.4 mm (1.080 in.) (see notes)
Pump rod (location)	Middle hole of pump arm
Idle mixture screw	2-5/8 turns out
Idle speed screw	2 turns past initial contact
Float weight	9 grams maximum
Main jet size	1.55 mm
TKS enrichment jet size	0.70 mm
Power valve size	0.74 mm
Venturi cluster I.D. number	472

NOTE: Float level and drop measurement taken from gasket.

NOTE: All measurements are $\pm 1/64$ in. (0.4 mm) unless otherwise listed.

NOTE: Float level measurements are ± 0.059 in. Float drop measurements are ± 0.075 in.

Gen 2 TKS Carburetors

Engine Model	4.3L
Carburetor number	866141
Float level	14 mm (0.550 in.) (see notes)
Float drop	27.4 mm (1.080 in.) (see notes)
Pump rod (location)	Middle hole of pump arm
Idle mixture screw	3-1/16 turns out
Idle speed screw	2 turns past initial contact
Float weight	9 grams maximum
Main jet size	1.55 mm
TKS enrichment jet size	0.70 mm
Power valve size	0.74 mm
Venturi cluster I.D. number	472

NOTE: Float level and drop measurement taken from gasket.

NOTE: All measurements are $\pm 1/64$ in. (0.4 mm) unless otherwise listed.

NOTE: Float level measurements are ± 0.059 in. Float drop measurements are ± 0.075 in.

Main Jet Sizes

Jet Size (mm)	Quicksilver Part Number
1.45	3302-9050
1.55	3302-811853
1.60	3302-810923
1.65	3302-9058
1.70	3302-9055

TKS Enrichment Jets

TKS Enrichment Jet Size (mm)	Carburetor Generation	Quicksilver Part Number
0.70	Gen 1	3310-866283
0.70	Gen 2	3310-866292

High Altitude Main Jet Re-Jetting

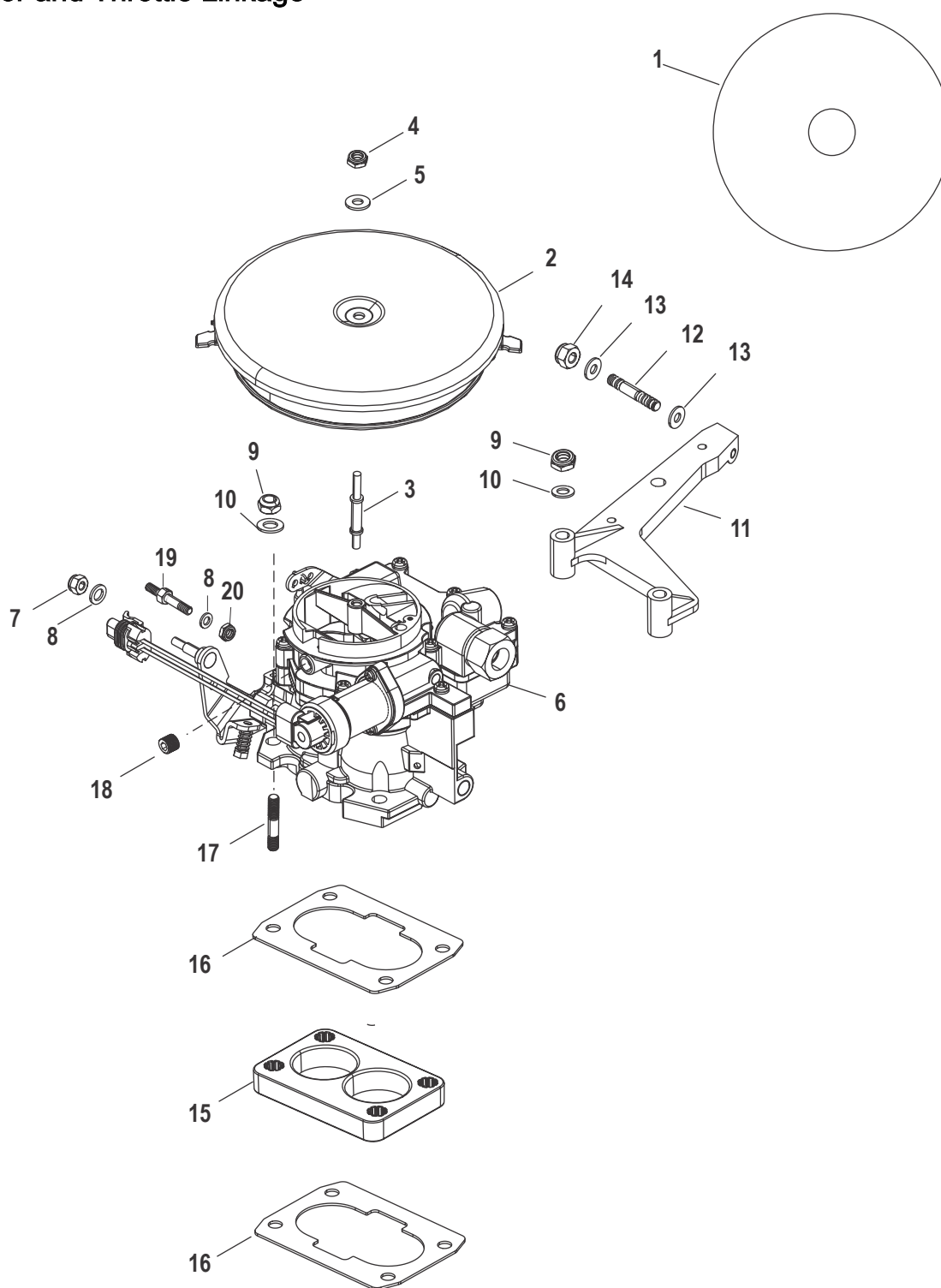
Model	5000 ft (1525 m) and below	5000–9000 ft (1525–2745 m)	9000 ft (2745 m) and above
4.3L	1.55 mm	1.55 mm	1.50 mm

NOTE: The TKS carburetor is more likely to need jets changed due to altitude than previous carburetors.

Power Valves

Power Valve Size (mm)	Quicksilver Part Number
0.65	3302-850424
0.74	3302-9435
0.90	3302-9059

Carburetor and Throttle Linkage



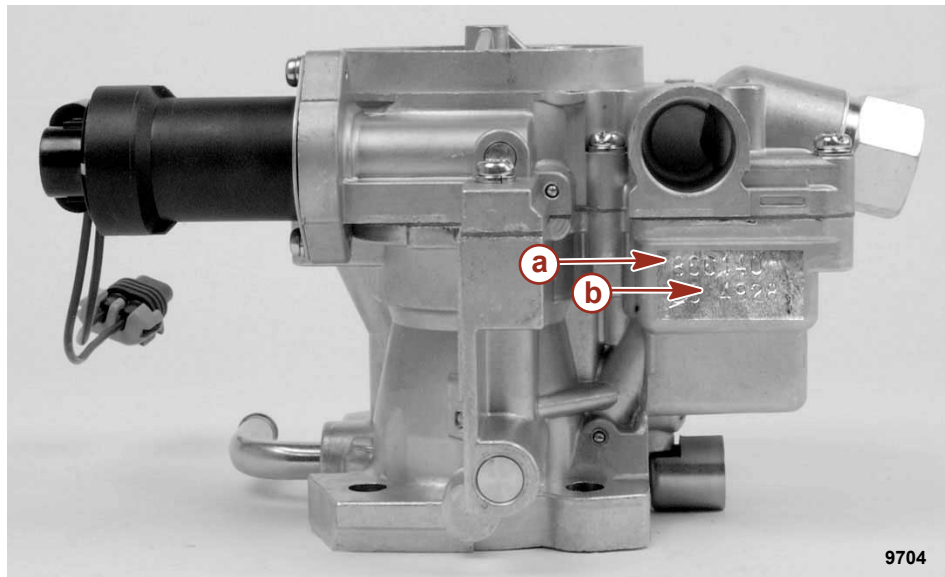
34060

Carburetor and Throttle Linkage

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cover decal			
2	1	Flame arrestor			
3	1	Stud (0.250-20/0.250-28 x special)			
4	1	Nut (0.250-28)			
5	1	Washer			
6	1	Carburetor			
7	1	Nut (0.250-28)			
8	2	Washer			
9	4	Nut (0.312-24)	27	–	20
10	2	Washer (0.328 x 0.562 x 0.062)			
10	2	Washer (0.328 x 0.750 x 0.062)			
11	1	Bracket			
12	1	Stud			
13	2	Washer (M4 x 20)			
14	1	Nut (0.250-28)			
15	1	Adapter			
16	2	Gasket			
17	1	Stud (0.312-18/0.312-24 x 3.380)			
17	1	Stud (0.312-18/0.312-24 x 2.120)			
18	1	Pipe plug (0.0625-27)			
19	1	Stud (0.250-28 x 2.00)			
20	1	Nut (0.250-28)			

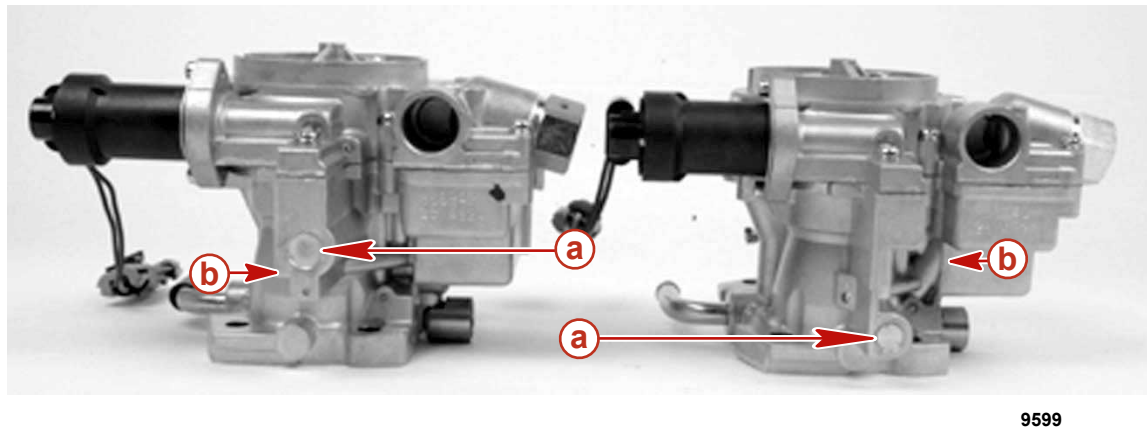
Identification

TKS Carburetor Part Number and Date Code



NOTE: A carburetor with a date code of 4928 was manufactured September 28, 2004.

Within the TKS line, there are two main variations, identified as Generation 1 (Gen 1) and Generation 2 (Gen 2). The differences are a minor change in the enrichment jet location and the height of the TKS enrichment fuel reservoir. This difference only slightly effects the rebuild and repair procedure, and will be noted in the appropriate location.



Typical Gen 1 (left) versus Gen 2 (right) carburetors

- a - TKS enrichment fuel reservoir
- b - TKS enrichment jet, not visible

Venturi Cluster Identification



Venturi cluster identification

- a** - Identification number (see specifications)

9729

Replacement Parts Warning

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

Important Service Information

8-Point Carburetor Check List

To ensure that the carburetor is the cause of the problem, make the following checks before ordering and installing a new carburetor. If questions 1, 2, 3, 5, 6, and 7 are YES and 8 is NO, the carburetor may not be the problem.

	Check	Yes	No
1	Does the TKS module flow extra fuel at warm-up?		
2	Does the TKS module stop extra fuel flow when engine is warm?		
3	Is the idle mixture screw set correctly? (Engines with Thunderbolt V ignition must have module locked in Base Timing Mode)		
4	What is the idle mixture screw setting?	# Turns _____	
5	Is the engine idle speed RPM correct?		
6	Is the venturi cluster discharging fuel by 2000 RPM?		
7	Is a good stream of fuel being discharged by both discharge holes in the venturi cluster when the throttle lever is moved repeatedly while the engine is off.		
8	Does the engine flood at idle?		

Flooding At Idle RPM

If your engine floods at idle RPM, check the following:

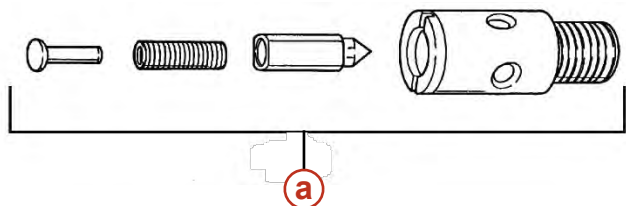
1. Problem in the ignition system causing the engine to run rough.
2. Verify the TKS module is working properly and causes the enrichment circuit to shut.
3. Verify the temperature switch is working properly and causes the TKS module to shut the enrichment circuit.
4. Idle mixture screw is adjusted correctly.
5. Bad needle and seat.
6. Incorrect float level or drop.

7. High fuel pressure.

Needle/Seat Change

IMPORTANT: Float needle and needle seat are factory matched and tested, and should be replaced as a set only.

TKS carburetors are factory equipped with a spring loaded needle.



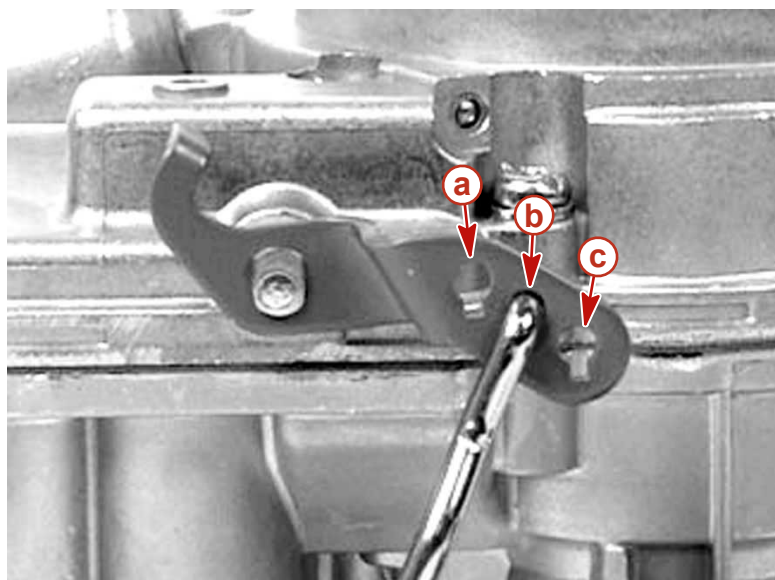
Needle and seat assembly

a - Spring loaded type needle

9549

Adjustable Accelerator Pump Lever

The adjustable accelerator pump lever is a 3-hole lever that allows you to change the amount of fuel delivered to the engine by the accelerator pump. Accelerator pump delivery will increase/decrease 0.8 cc per hole.



Adjustable accelerator pump lever

a - Third hole - richer

b - Second hole - center

c - First hole - leaner

9966

When installing the 3-hole lever, ensure that the duration spring on the accelerator pump is stock and hasn't had coils removed. Ensure that the correct venturi cluster is being used.

Description

The MerCarb carburetor is a two bore carburetor that has a separate fuel feed for each venturi. This TKS model is equipped with a TKS module. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel/air mixture to the engine.

Flame Arrestor

Removal

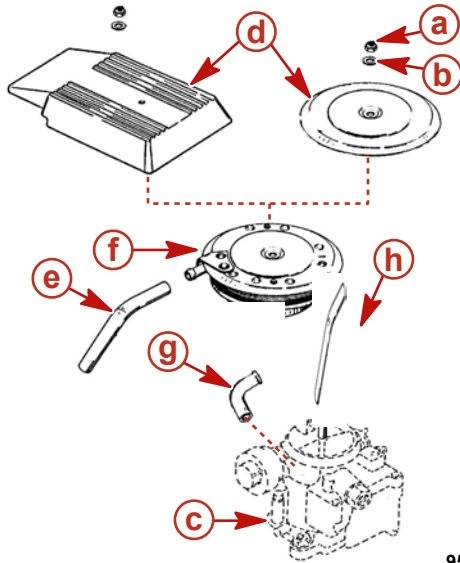
1. Remove the nut on top of the carburetor cover.
2. Remove the sealing washer.
3. Remove the carburetor cover.
4. Remove the crankcase ventilation hose from the flame arrestor and starboard rocker arm cover.
5. Remove the positive crankcase vent (PCV) hose to the carburetor tube and port rocker arm PCV valve connection.
6. Remove the flame arrestor.

Cleaning and Inspection

1. Clean the flame arrestor in solvent and blow dry with compressed air.
2. Clean the crankcase ventilation and PCV hoses.
3. Inspect the hoses for cracks or deterioration, and replace if necessary.

Installation

1. Install the flame arrestor.
2. Install the crankcase ventilation hose to the flame arrestor and the starboard rocker arm cover.
3. Install the positive crankcase vent (PCV) hose from the port rocker arm PCV valve connection to the carburetor tube.
4. Install the carburetor cover.
5. Install the sealing washer.
6. Install the nut. Tighten securely.



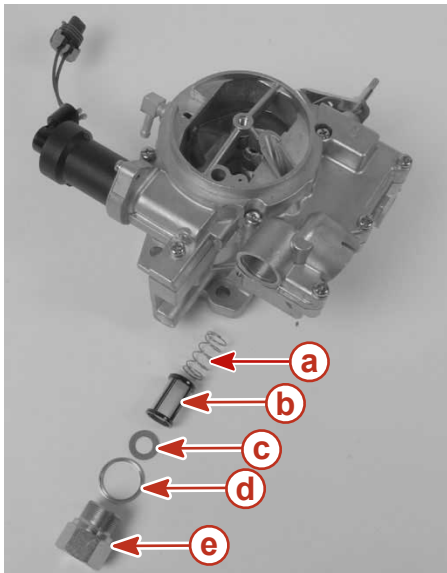
- a - Nut
- b - Sealing washer
- c - Carburetor
- d - Cover (depending on model)
- e - Crankcase ventilation hose
- f - Flame arrestor
- g - Positive crankcase vent (PCV) hose (on carburetor)
- h - Positive crankcase vent (PCV) hose

9529

Fuel Inlet Filter

Removal

1. Remove the fuel line from the fuel inlet filter nut.
2. Remove the fuel inlet filter nut and small gasket.
3. Remove the large gasket.
4. Remove the filter.
5. Remove the spring.
6. Remove the small gasket from inside the filter nut.



- a - Spring
- b - Filter
- c - Gasket (small)
- d - Gasket (larger)
- e - Fuel inlet filter nut

9530

Cleaning

Clean the filter nut and the spring in solvent and dry with compressed air.

Installation

1. Install the spring into the carburetor body.
2. Install the filter, open end to the inlet filter nut.
3. Install the small gasket inside the filter nut.
4. Install the large gasket over the filter nut threads.
5. Install the fuel inlet filter nut. Tighten the inlet filter nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Inlet filter nut	24	–	18

IMPORTANT: Hold the filter nut with a wrench while you tighten the fuel line to the specified torque.

6. Install the fuel line. Tighten the fuel line fitting to the specified torque.

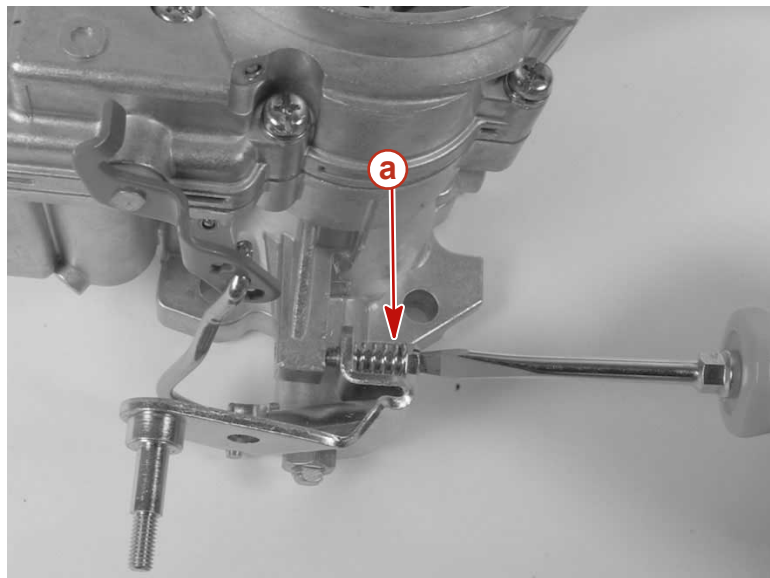
Description	Nm	lb-in.	lb-ft
Fuel line fitting	24	–	18

Adjustments

Initial Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting the engine. Final adjustments must be made with the engine running and warm, and the TKS enrichment system fully closed.

1. Loosen the idle speed screw until it no longer contacts the idle speed screw block.



a - Idle speed screw

9535

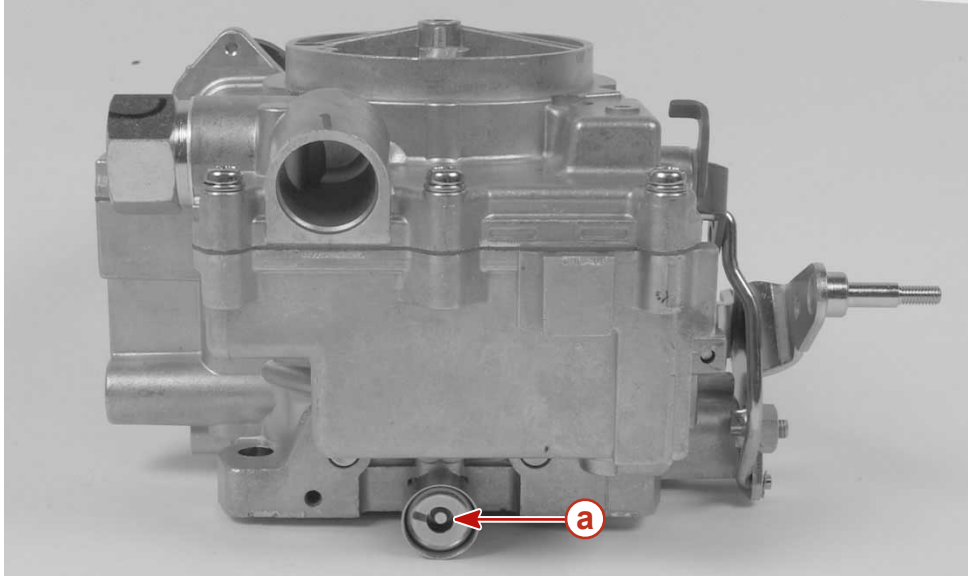
2. Turn the idle speed screw in, until it just contacts the idle speed screw block, then turn the screw in as specified for the particular carburetor as found in the **Idle Speed Screw Settings** table.

NOTE: All settings are from the initial contact of the screw to the block.

Idle Speed Screw Settings	
TKS Carburetor	4.3L
Gen 1	2 turns
Gen 2	2 turns

IMPORTANT: Do not turn the idle mixture needle tightly against the seat (in the following step), as damage to the seat and/or needle may result.

3. Turn the idle mixture screw in until lightly seated, then loosen the screw as found in the **Idle Mixture Screw Settings** table below.



9536

a - Idle mixture screw

NOTE: The idle mixture screw can only be accessed with a special tool. See the **Idle Mixture Screw Settings** table below for your engine's specifications.

NOTE: All settings are from the idle mixture screw being lightly seated.

Idle Mixture Screw Settings	
Generation/Engine	4.3L
Gen 1	2-5/8 turns out
Gen 2	3-1/16 turns out
Idle Mixture Adjusting Screw	91-866201

Carburetor Removal and Installation

Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect the battery.
2. Remove the crankcase ventilation and PCV hose from the flame arrestor.
3. Remove the flame arrestor.
IMPORTANT: Place a clean cloth in the bores of the carburetor to prevent dirt and foreign material from falling into the bores.
4. Turn the fuel supply off at the fuel tank.
5. Disconnect the throttle cable from the carburetor.
6. Remove the fuel line from the fuel inlet nut, using a wrench to stabilize the fuel inlet nut.
7. Disconnect the TKS module.
8. Remove the carburetor attaching nuts and washers and remove the carburetor.
IMPORTANT: Place a clean cloth over the intake manifold opening to prevent dirt or foreign material from entering the manifold.
9. Remove and discard the carburetor to the manifold gaskets.

Installation

1. Clean the gasket surfaces.
2. Use new gaskets and install the carburetor.
3. Place the circuit breaker bracket onto the studs above the rear of the carburetor as the carburetor is being placed onto the intake manifold.
4. Place the washers and nuts on the studs. Tighten the nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Carburetor to manifold nuts	27	–	20

5. Connect the fuel line. Hold the carburetor filter nut with a wrench and tighten the fuel line fitting to the specified torque.

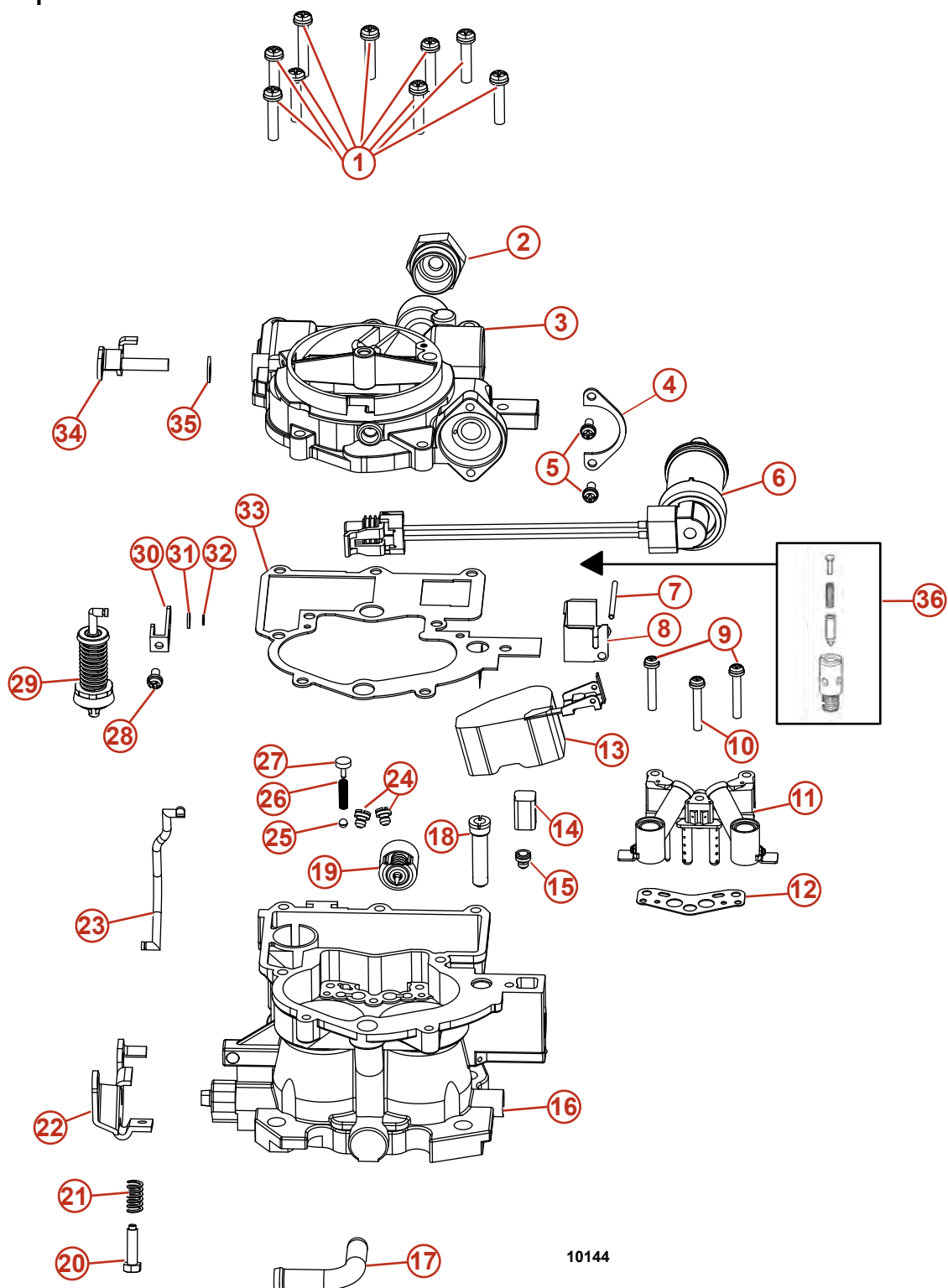
Description	Nm	lb-in.	lb-ft
Fuel line to carburetor	24	–	18

6. Reconnect the TKS connector, vent hoses, and the flame arrestor.
7. Connect the battery.
8. Refer to **Adjustments** in this section for initial idle speed and mixture settings. Final adjustments must be made with the engine running and warm, when the TKS enrichment system is fully closed.
9. Refer to **Throttle Cable Installation and Adjustment** in **Section 2B** of this manual for throttle cable adjustment.

Notes:

Carburetor Cleaning and Repair

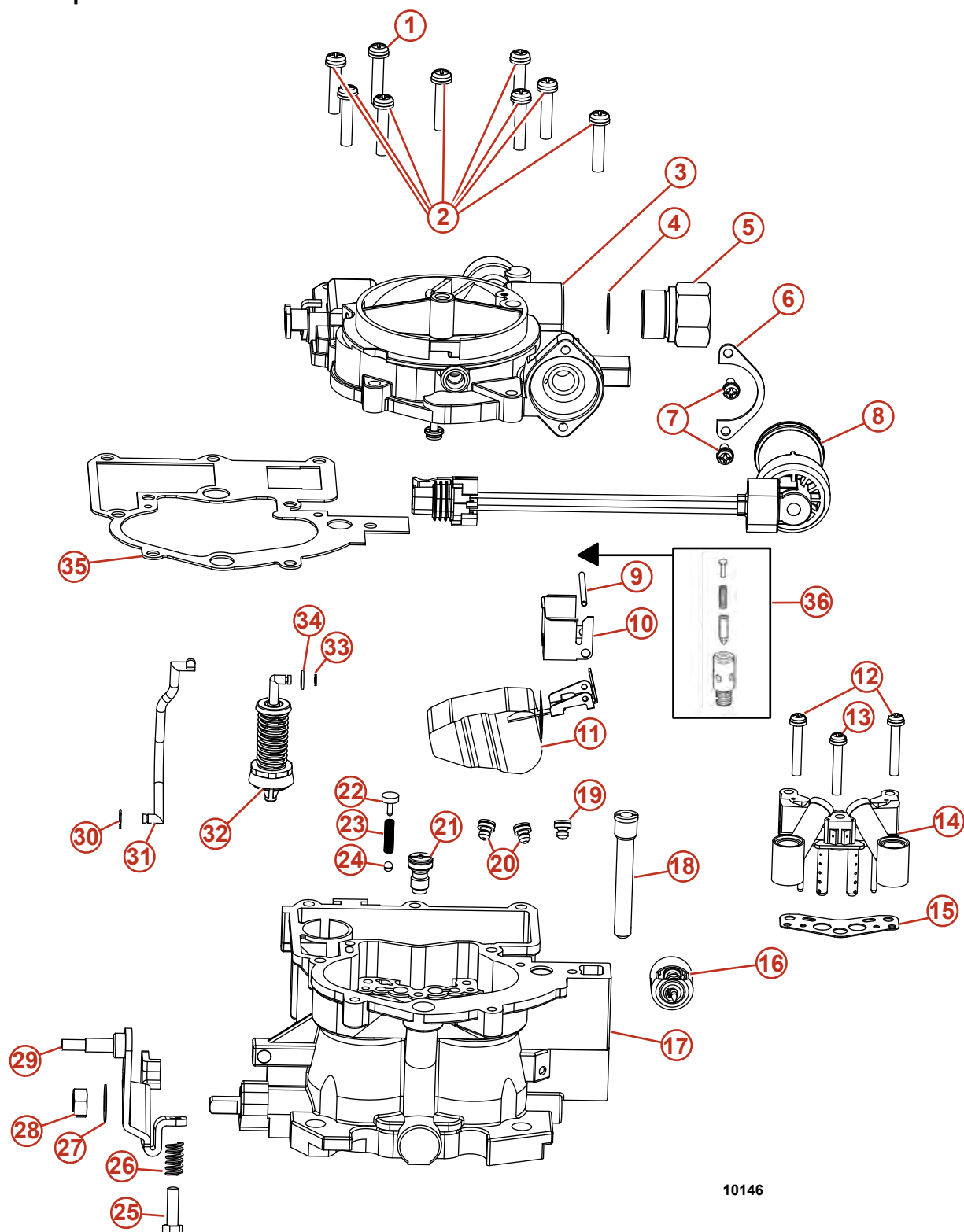
Gen 1—Exploded View



Gen 1—Exploded View

Ref. No.	Qty	Description
1	9	Air horn screw
2	1	Fuel inlet nut
3	1	Air horn
4	1	C-clip for TKS module
5	2	Screw
6	1	TKS module
7	1	Float pin
8	1	Baffle plate
9	2	Venturi screws with metal washer
10	1	Venturi screw with fiber washer
11	1	Venturi cluster
12	1	Gasket
13	1	Float
14	1	Volume reduction plug
15	1	TKS enrichment jet
16	1	Carburetor body
17	1	PCV tube connection fitting (not used)
18	1	Emulsion tube
19	1	Idle mixture adjusting needle
20	1	Idle speed adjustment screw
21	1	Idle speed adjustment spring
22	1	Throttle lever
23	1	Accelerator pump rod
24	2	Main jets
25	1	Check ball
26	1	Spring
27	1	Retainer
28	1	Set screw
29	1	Spring accelerator pump assembly
30	1	Accelerator pump assembly lever
31	1	Washer
32	1	C-clip
33	1	Gasket
34	1	Accelerator pump lever
35	1	Washer
36	1	Inlet needle and seat (spring loaded)
Not visible on this drawing: Fuel inlet filter and spring, fuel inlet gasket, power valve assembly, accelerator pump return spring		

Gen 2—Exploded View



10146

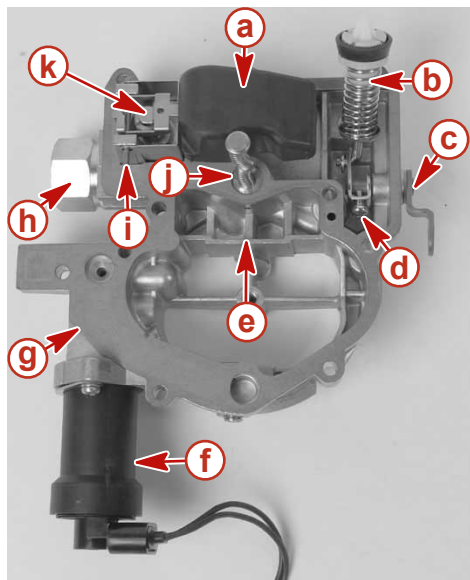
Gen 2—Exploded View

Ref. No.	Qty	Description
1	1	Air horn screw - long
2	8	Air horn screw - short
3	1	Air horn
4	1	Gasket
5	1	Fuel inlet nut
6	1	C-clip for TKS module
7	2	Screws
8	1	TKS module
9	1	Float pin
10	1	Baffle plate
11	1	Float
12	2	Outer venturi screw
13	1	Center venturi screw with fiber washer
14	1	Venturi cluster
15	1	Gasket
16	1	Idle mixture adjusting needle
17	1	Carburetor body
18	1	Emulsion tube
19	1	TKS enrichment jet
20	2	Main jets
21	1	Power valve assembly
22	1	Retainer
23	1	Spring
24	1	Check ball
25	1	Idle speed adjustment screw
26	1	Spring
27	1	Washer
28	1	Nut
29	1	Throttle lever
30	1	Pump rod clip
31	1	Accelerator pump rod
32	1	Accelerator pump shaft and lever assembly
33	1	Retainer clip
34	1	Washer
35	1	Gasket
36	1	Inlet needle and seat (spring loaded)
Not visible on this drawing: Fuel inlet filter and spring, lever assembly with set screw.		

Repair

Carburetor problems are, in many cases, caused by the presence of dirt, water, or other foreign matter in the carburetor. To aid in diagnosis, carefully remove the carburetor from the engine without draining fuel from the bowl. Contents of the fuel bowl may then be inspected for contamination as the carburetor is disassembled.

Air Horn Assembly

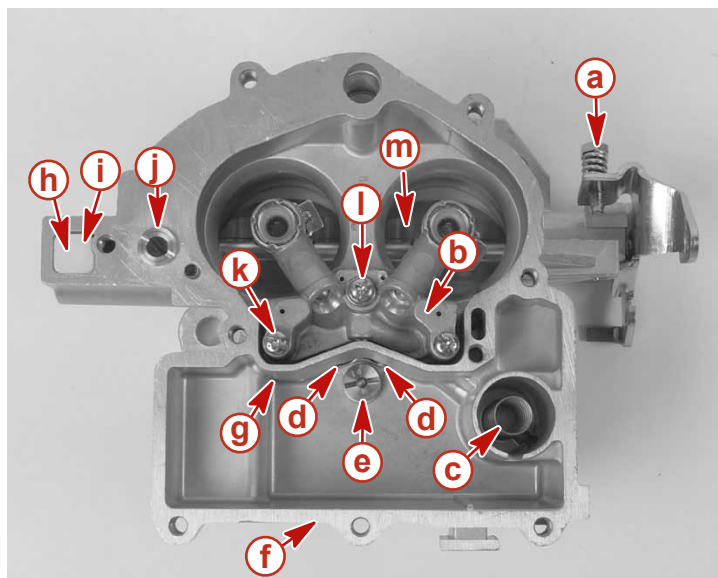


9887

Air horn assembly, Gen 1 and Gen 2

- a** - Float
- b** - Accelerator pump assembly
- c** - Accelerator pump lever
- d** - Set screw
- e** - Air horn (not available separately)
- f** - TKS module
- g** - Air horn gasket
- h** - Fuel inlet nut
- i** - Baffle
- j** - Power valve assembly
- k** - Needle and seat assembly

Float Bowl Assembly, Gen 1

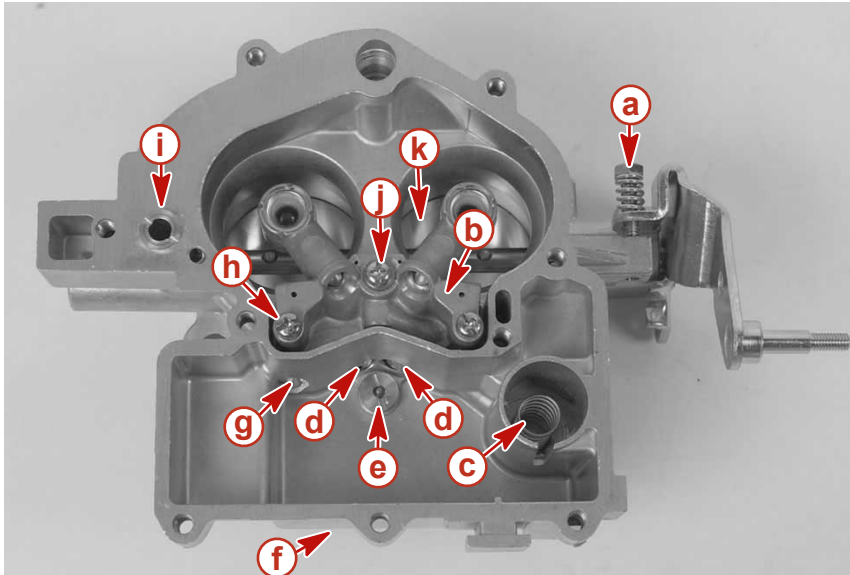


9888

Gen 1 float bowl assembly

- a** - Idle speed screw and spring
- b** - Venturi
- c** - Accelerator pump return spring
- d** - Main jet
- e** - Power valve
- f** - Idle mixture screw (under float bowl)
- g** - Fuel inlet for TKS fuel enrichment reservoir
- h** - Volume reduction plug
- i** - TKS fuel enrichment metering jet (under plug)
- j** - Emulsion tube
- k** - Venturi screw with washer and lockwasher
- l** - Venturi screw with washer and fiber washer
- m** - Throttle plates (not serviceable)

Float Bowl Assembly, Gen 2



9890

Gen 2 float bowl assembly

- a** - Idle speed screw and spring
- b** - Venturi
- c** - Accelerator pump return spring
- d** - Main jet
- e** - Power valve
- f** - Idle mixture screw (under float bowl)
- g** - TKS fuel enrichment metering jet
- h** - Venturi screw with washer and lockwasher
- i** - Emulsion tube
- j** - Venturi screw with washer and fiber washer
- k** - Throttle plates (not serviceable)

Disassembly

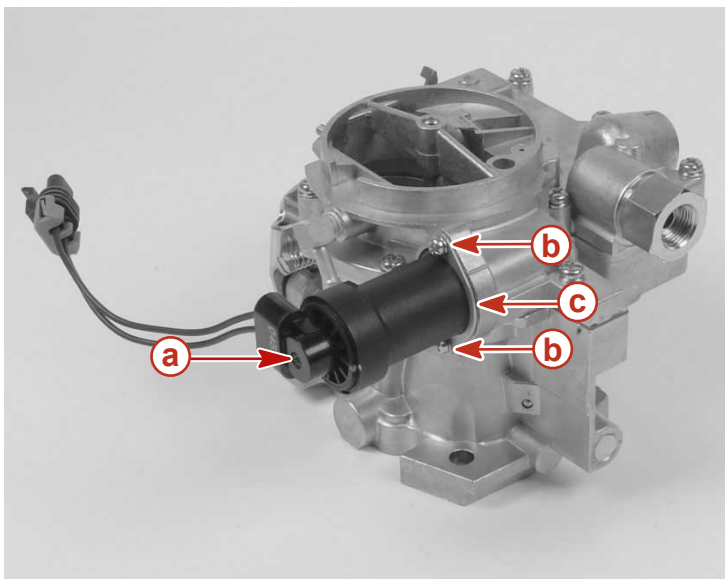
IMPORTANT: Before performing any service on the carburetor, it is essential that the carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

The following is a step-by-step procedure for completely overhauling the carburetor removed from the engine. Complete overhaul is not always necessary. You should perform only those steps required to repair the carburetor malfunction. Read the instructions carefully to prevent unnecessary steps.

TKS Module

The TKS module is not a serviceable part. It is adjusted at the factory for proper performance. If the TKS module is not working properly, replace the unit.

1. Refer to **Carburetor Removal and Installation** in this section for carburetor removal procedures.
2. Remove the two screws and C-clip holding the TKS module.



9630

- a** - TKS module
- b** - Screws
- c** - C-clip

3. Carefully remove the TKS module from the carburetor body by pulling the module straight out using a slight twisting motion, being careful not to damage the O-ring.

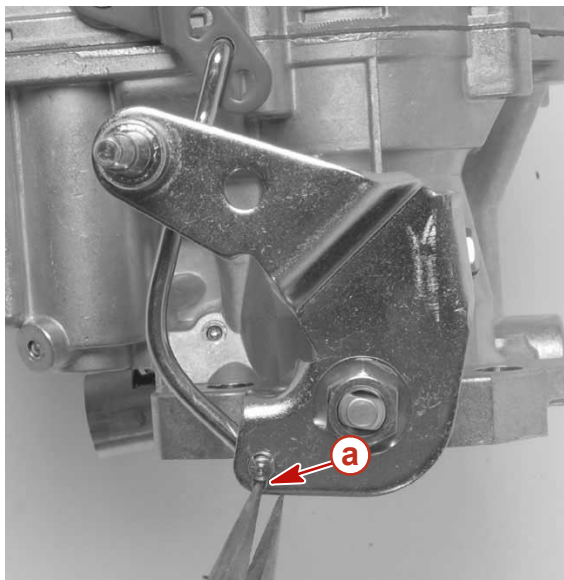


a - O-ring on TKS module

9633

Air Horn

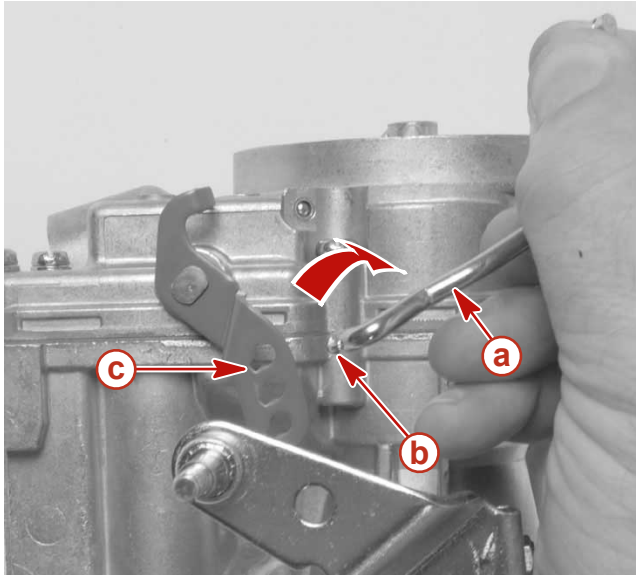
1. Remove the fuel inlet filter nut, washers, spring, and the filter, as outlined previously.
2. Remove the accelerator pump rod retaining clip.



a - Retaining clip

9586

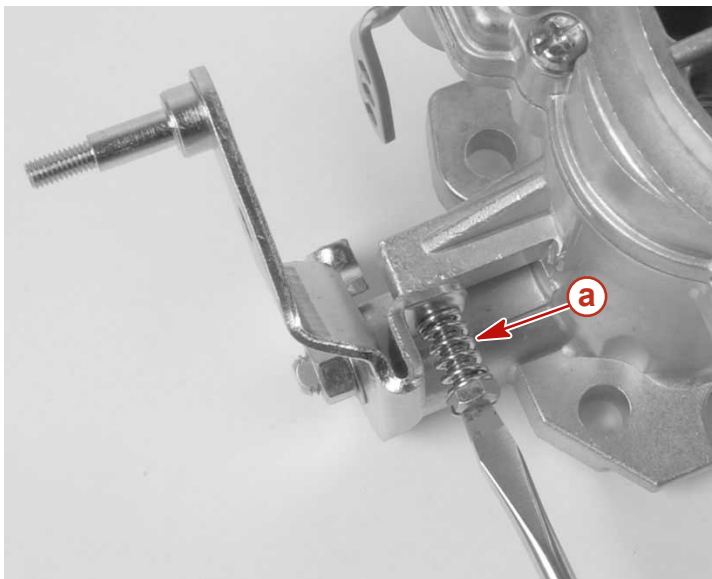
3. Pivot the accelerator pump rod (as required) until the retaining ear on the rod and the slot in the pump shaft and lever assembly align, allowing rod to be pulled out.



- a - Accelerator pump rod
- b - Retaining ear
- c - Pump shaft and lever slot

9540

4. Remove the idle speed adjustment screw and spring, if replacement is necessary.

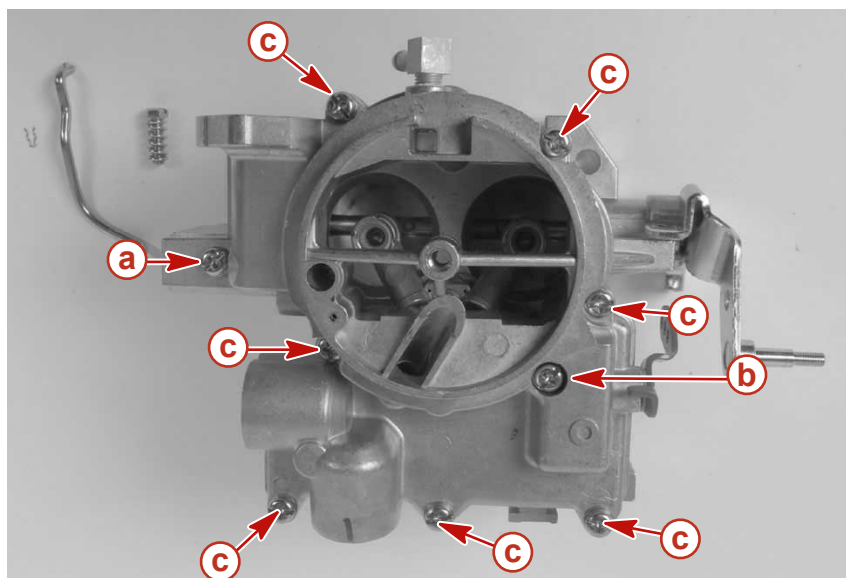


- a - Idle speed screw and spring

9558

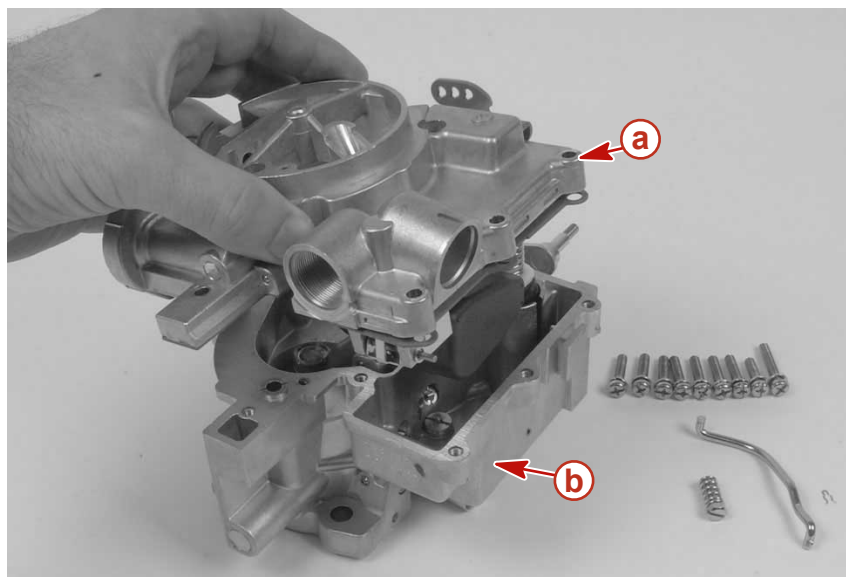
IMPORTANT: Do not remove the throttle valves. If any of the throttle parts are found to be worn or damaged, the complete carburetor body assembly **MUST BE** replaced. Assembly can be cleaned in carburetor cleaner.

5. Remove the air horn attaching screws. Note lengths and locations for assembly.



9581

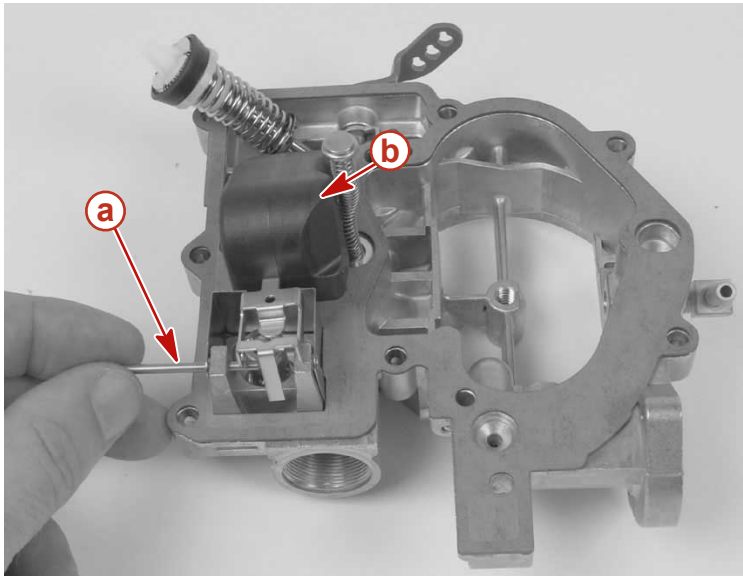
6. Carefully lift the air horn from the float bowl assembly.



9543

7. Invert the air horn and carefully lay it on the bench.

8. Remove the float hinge pin and lift the float assembly from the air horn.



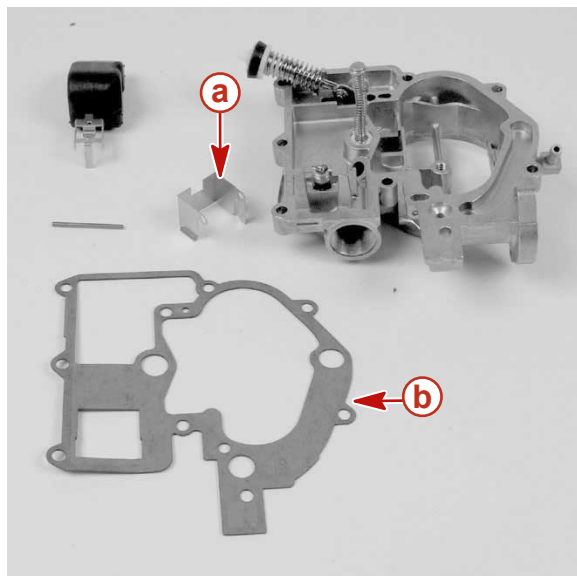
- a** - Float hinge pin
b - Float assembly

9. Check the float weight. Replace if it weighs more than the specification in the table at the front of this section.



- a** - Float

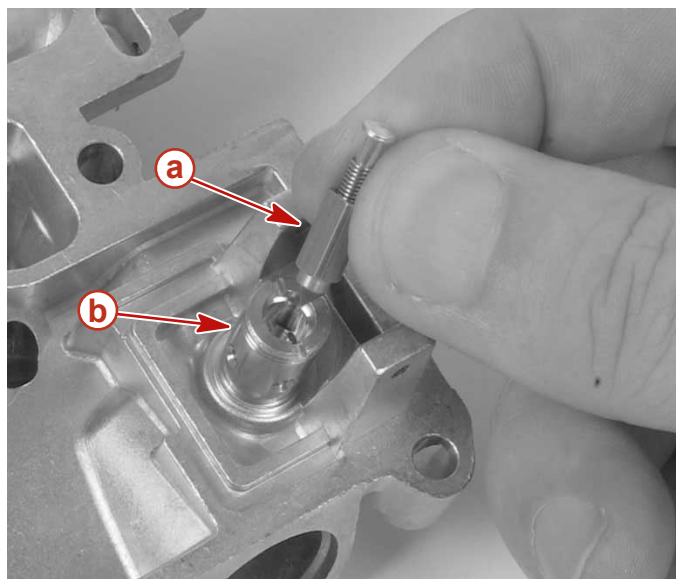
10. Remove the air horn gasket and baffle.



- a** - Baffle
b - Air horn gasket

9573

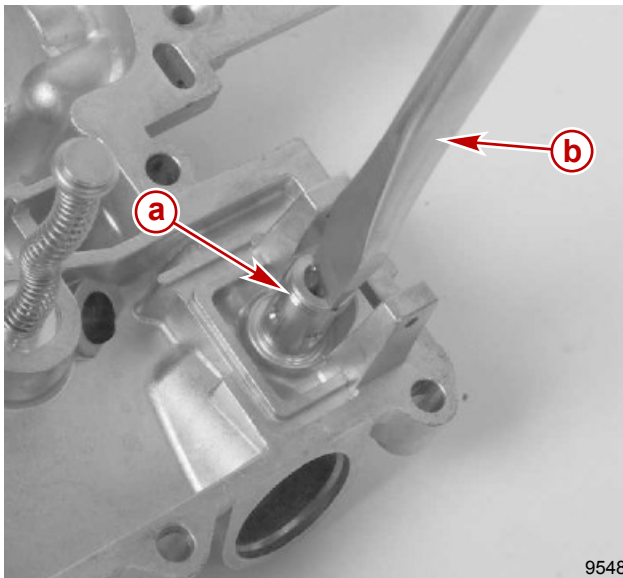
11. Remove the needle assembly.



- a** - Needle assembly
b - Needle seat

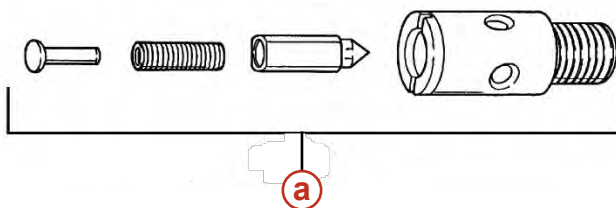
9547

12. Remove the needle seat.



- a** - Needle seat
b - Screwdriver

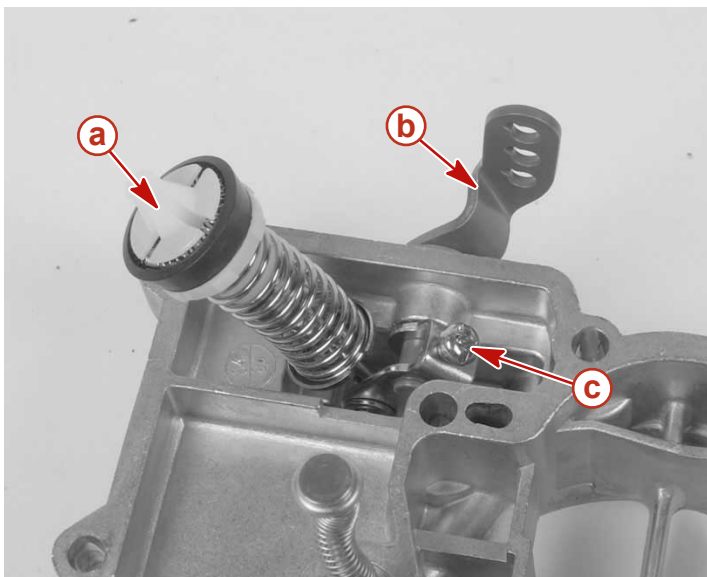
13. Keep the needle and the seat assembly together as a set, as they are matched from the factory and should be replaced as a set if necessary.



- Needle and seat assembly**
a - Spring loaded type needle

9549

14. Loosen the accelerator pump screw.

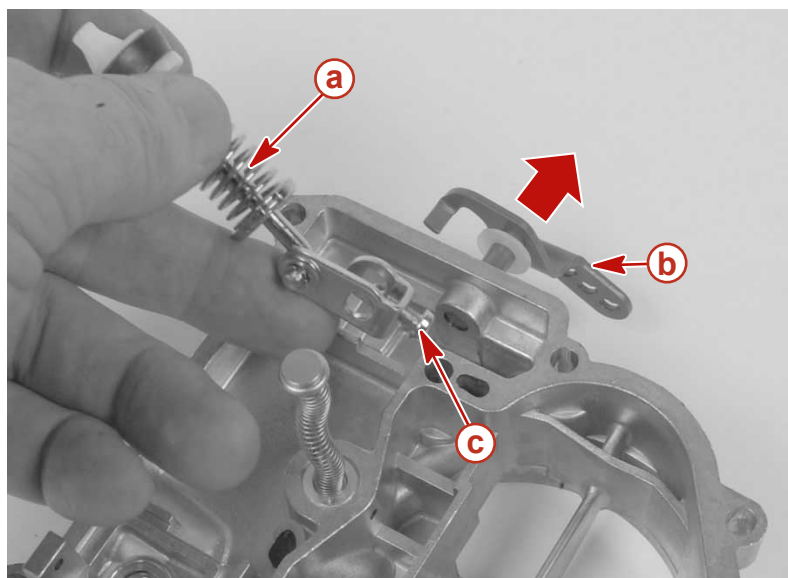


- a** - Accelerator pump assembly
b - Accelerator pump lever
c - Set screw

9550

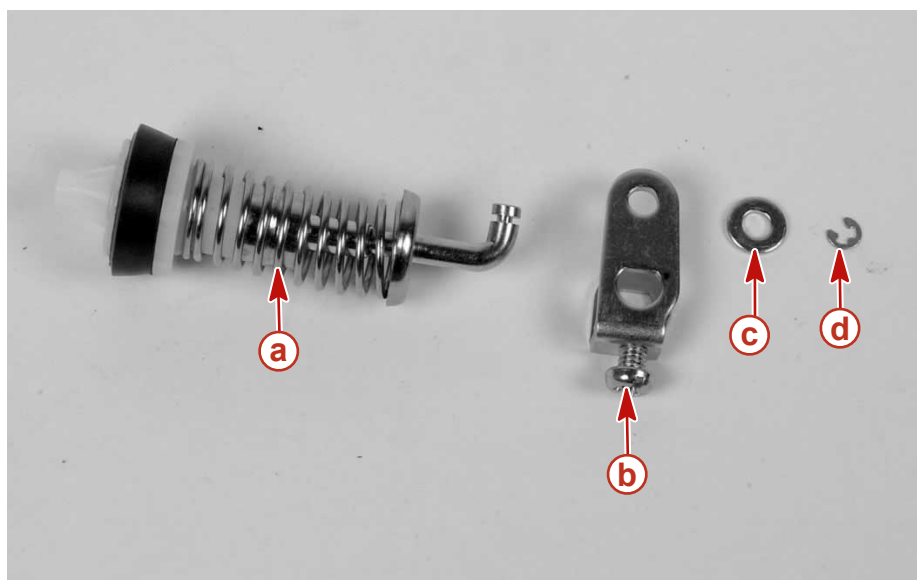
15. Slide the pump shaft and the lever assembly (and washer) out of the air horn.

16. Remove the accelerator pump assembly.



- a** - Accelerator pump assembly
- b** - Accelerator pump lever
- c** - Set screw

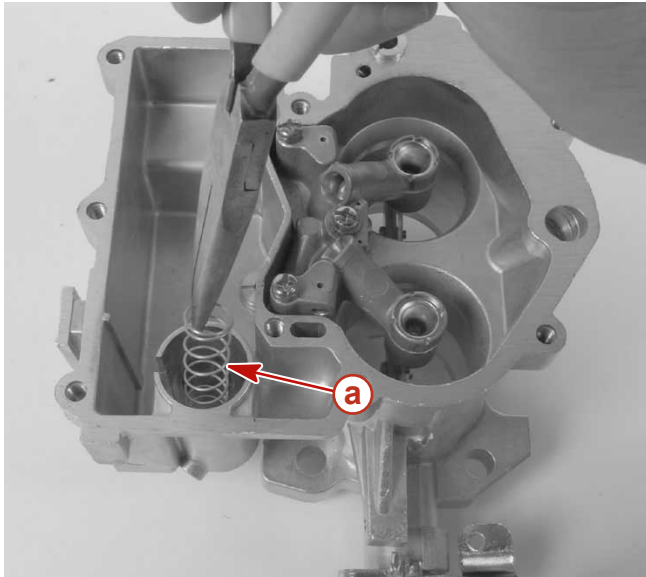
17. Remove the retainer clip and the washer from the pump shaft and lever assembly, then remove the accelerator pump assembly.



- a** - Pump assembly
- b** - Lever assembly
- c** - Washer
- d** - Retainer clip

Float Bowl

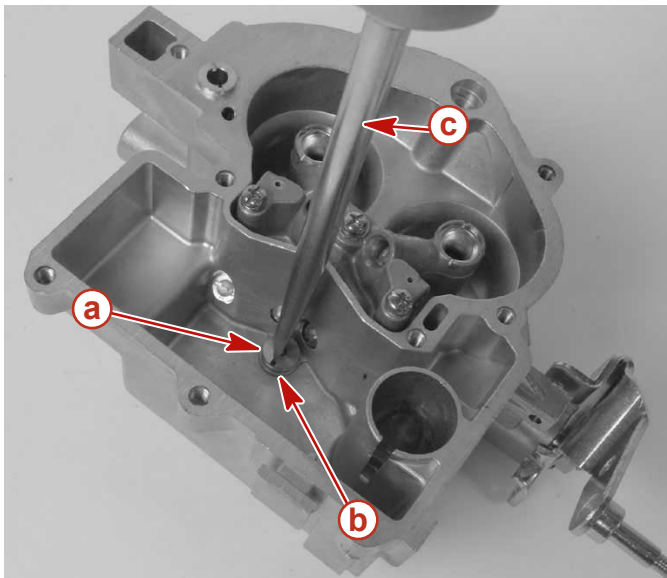
1. Remove the accelerator pump return spring from the pump well.



a - Accelerator pump return spring

9552

2. Remove the power valve assembly and the gasket.



Gen 2 carburetor shown

a - Power valve assembly

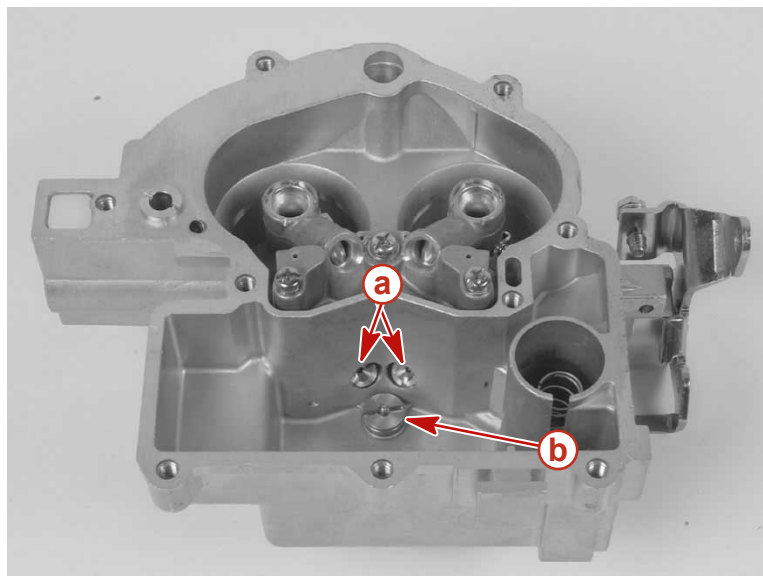
b - Gasket (not shown)

c - Screwdriver

9553

3. **Gen 1:** Remove the metering jets. Note sizes to keep the main jets separate from the TKS fuel enrichment metering jet.

- a. Remove the main jets.



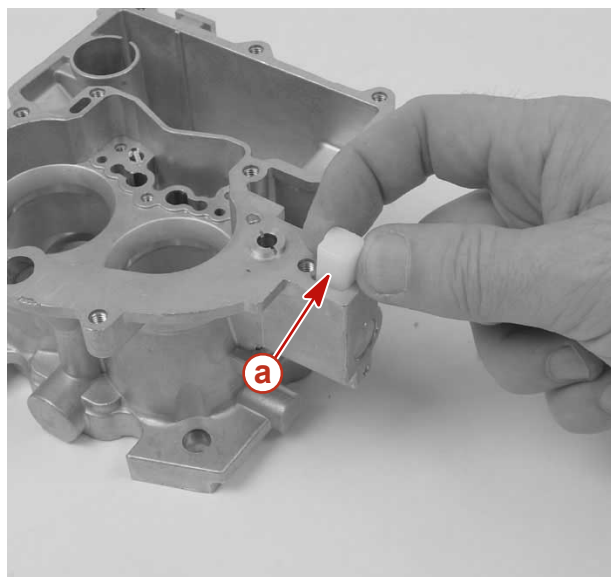
Gen 1 float bowl

a - Main jets

b - Power valve

9669

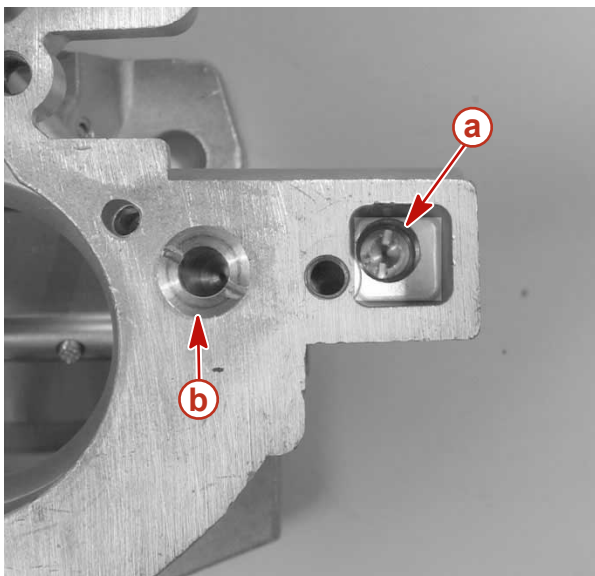
- b. Remove the volume reduction plug. Pry loose with a small screwdriver, then turn float bowl over so it drops out.



a - Volume reduction plug

9883

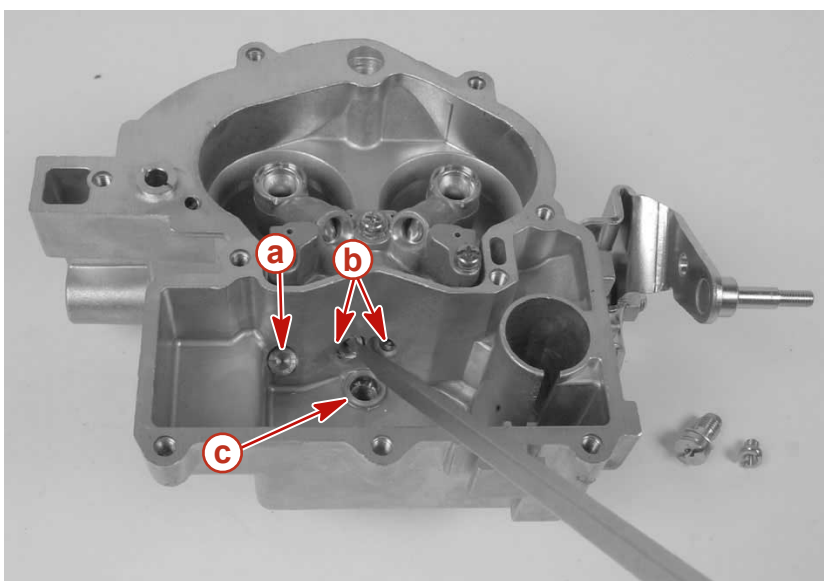
- c. Remove the TKS enrichment jet at the bottom of the well.



- a - TKS fuel enrichment jet
b - Emulsion tube

9884

4. **Gen 2:** Remove the metering jets. Note sizes to keep the main jets separate from the TKS fuel enrichment jets.
a. Remove the main jets.

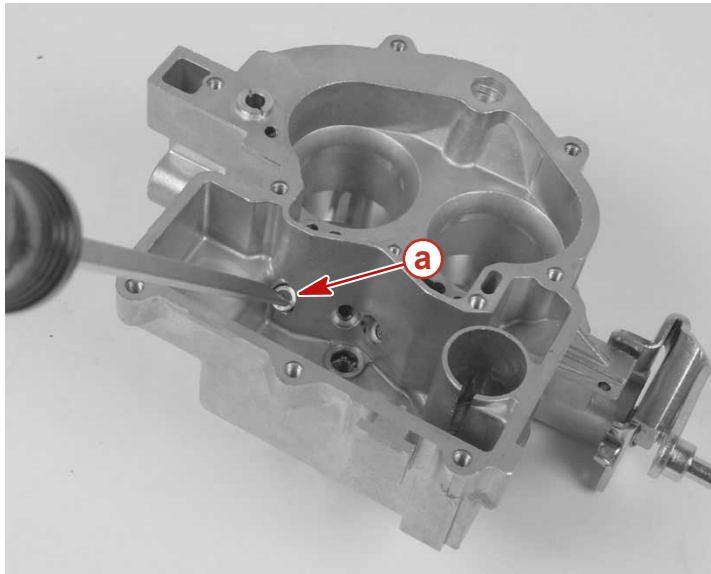


Gen 2 float bowl

- a - TKS fuel enrichment jet
b - Main jets
c - Power valve port

9554

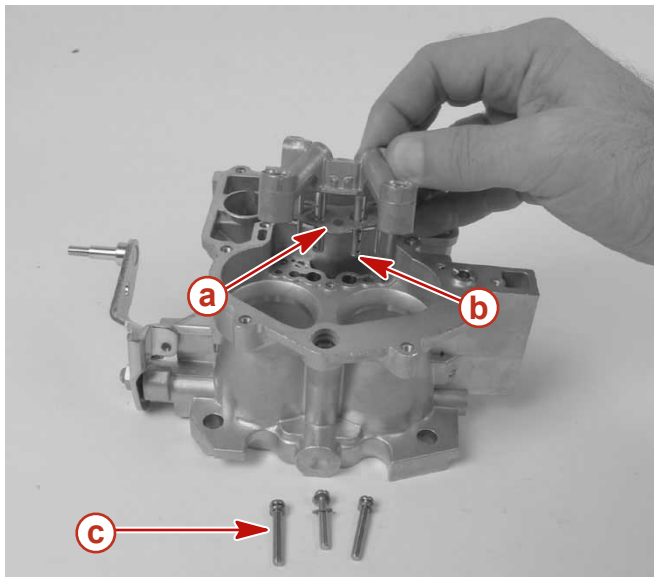
- b. Remove the TKS enrichment jet. Note size to keep separate from the main jets.



a - TKS enrichment jet

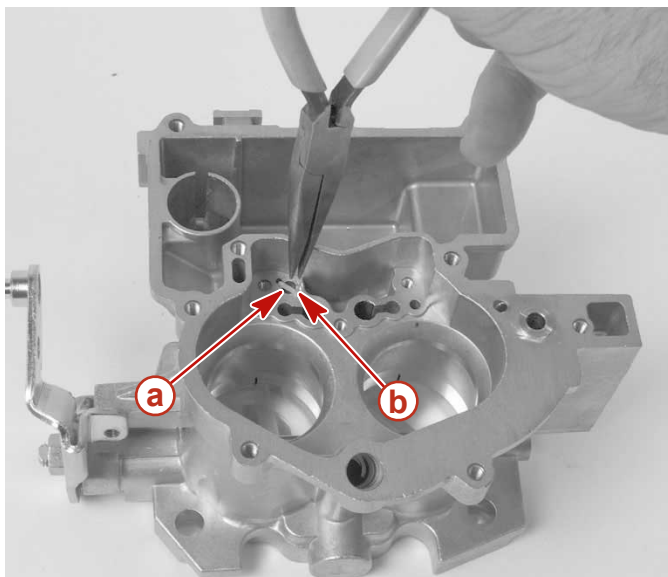
IMPORTANT: Use care when removing the venturi cluster to prevent damaging the brass tubes which protrude from the bottom of the cluster. Do not remove the tubes. These tubes are permanently pressed into the venturi cluster and are not replaceable.

5. Remove the venturi cluster screws, and carefully lift the cluster and venturi gasket straight up.



a - Venturi cluster brass tubes
b - Gasket
c - Screws

6. Using a needle-nose pliers, remove the accelerator pump check ball spring retainer. Turn the float bowl over to remove spring and check ball.

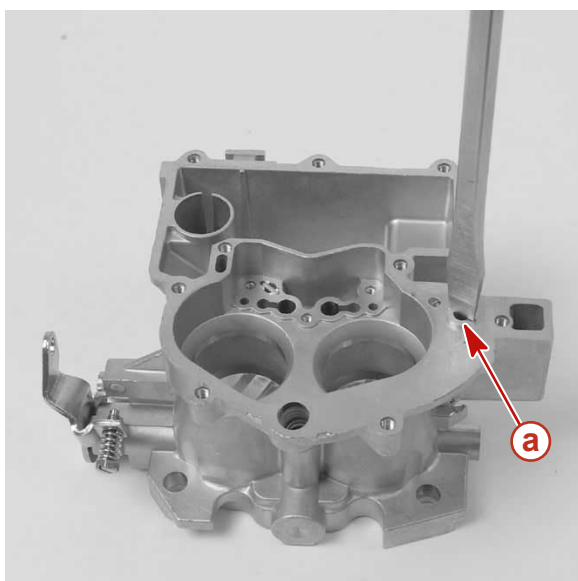


- a** - Spring retainer
- b** - Spring and check ball (not shown)

9556

IMPORTANT: Use extreme care when handling the carburetor body, so as not to damage the throttle valves.

7. Remove the emulsion tube.

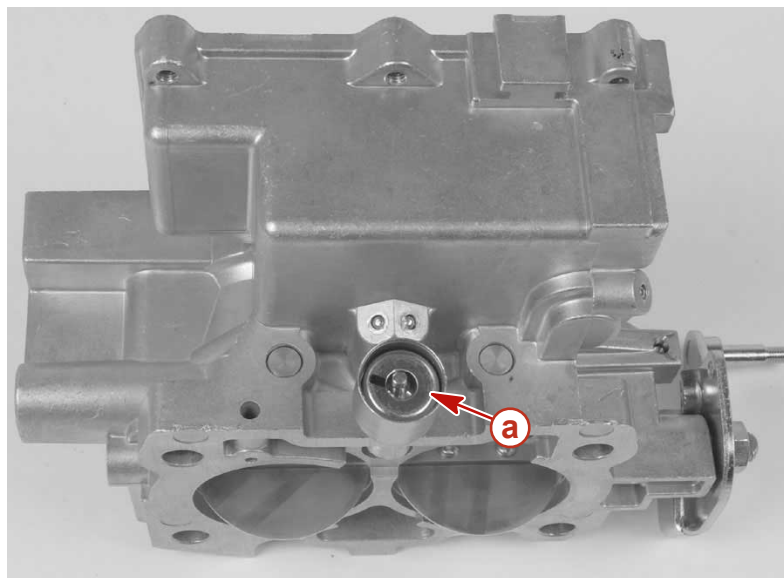


Gen 1 carburetor shown

- a** - Emulsion tube

9885

8. Remove the idle mixture adjusting needle assembly using the special idle mixture adjusting tool.



a - Idle mixture adjusting needle

9557

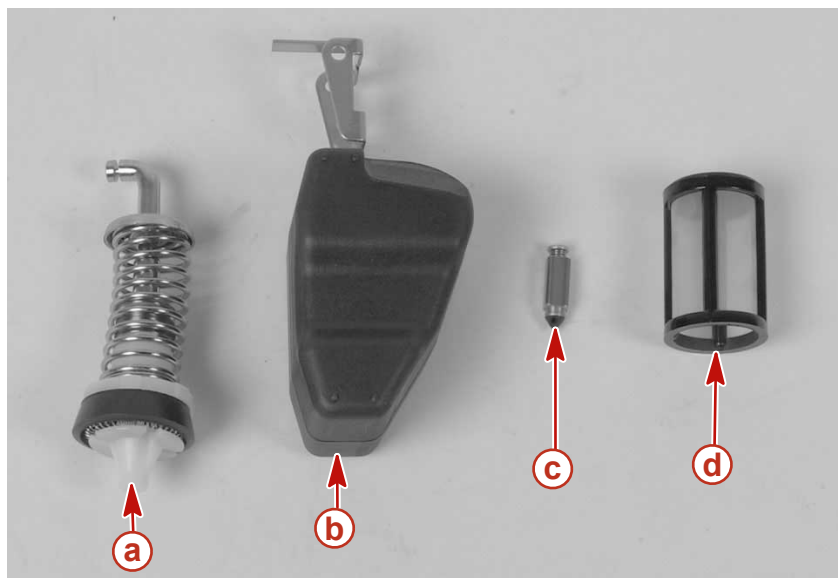
Cleaning and Inspection

IMPORTANT: Do not use a wire or drill to clean jet passages or tubes in the carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

IMPORTANT: To prevent damage, do not leave the carburetor in an immersion-type carburetor cleaner for more than two hours.

IMPORTANT: Do not clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

IMPORTANT: To prevent damage to components, do not immerse the carburetor float assembly, float needle, accelerator pump plunger, or fuel filter in carburetor cleaner.



Items not to be immersed in carburetor cleaner

- a -** Accelerator pump plunger
- b -** Float assembly
- c -** Float needle
- d -** Fuel filter

9559

⚠ CAUTION

Using compressed air can cause serious injury. Always wear eye protection when working with compressed air to prevent injury from ruptured hoses or flying debris.

1. Clean all the metal parts in a commercial carburetor cleaner until all deposits have been removed. Follow the cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all the passages in the carburetor to remove any foreign material.

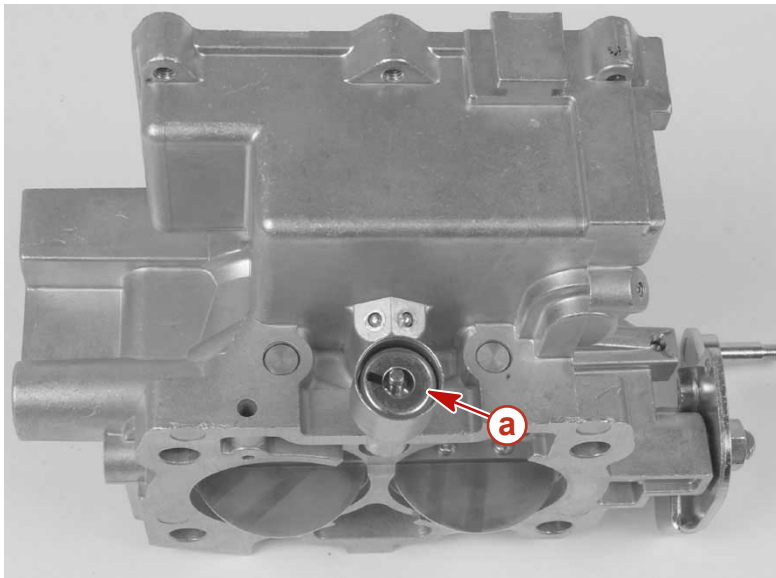
3. Wipe off all the parts that cannot be cleaned in the carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all the carburetor parts for wear and damage. Pay particular attention to the following:
 - a. The float needle and seat: If the float needle or the seat is worn or damaged, replace with a new needle and seat assembly.
IMPORTANT: The float needle and seat are factory matched and tested and should be replaced as a set only.
 - b. The float assembly and hinge pin: Check float density (to see if it is saturated with fuel) by comparing the weight of float with specifications. If the weight is high, the float assembly must be replaced. Check the hinge pin and holes for wear.
 - c. The fuel and air passages: Passages must be perfectly clean for proper carburetor operation.
 - d. The accelerator pump plunger and return spring: Inspect the pump plunger cup, pump plunger spring (on the pump assembly), and the return spring.
 - e. The power piston spring: Check the power piston spring for weakness or distortion.
 - f. The idle mixture needle: Inspect the idle mixture needle. If damaged, the needle must be replaced.
 - g. The levers and linkages: Check the levers, links, and rods for wear.
 - h. The throttle valve and shaft: Check the throttle shaft for excessive looseness in the throttle body. Ensure the throttle valve and the shaft open and close completely. The throttle body assembly must be replaced if the throttle valve and shaft are worn or damaged.
 - i. The TKS module operation: Follow the diagnostic tests listed in this section.
 - j. Inspect casting for visible damage. Inspect the gasket surfaces. Inspect the accelerator pump plunger well for scoring or deposits.

Reassembly

Carburetor Body

IMPORTANT: Do not force idle mixture needle against the seat as damage to the needle and/or seat will result.

1. Screw the idle mixture needle and spring into the throttle body until it lightly seats, then back out the idle mixture screw as specified for your model to attain the preliminary idle mixture setting.

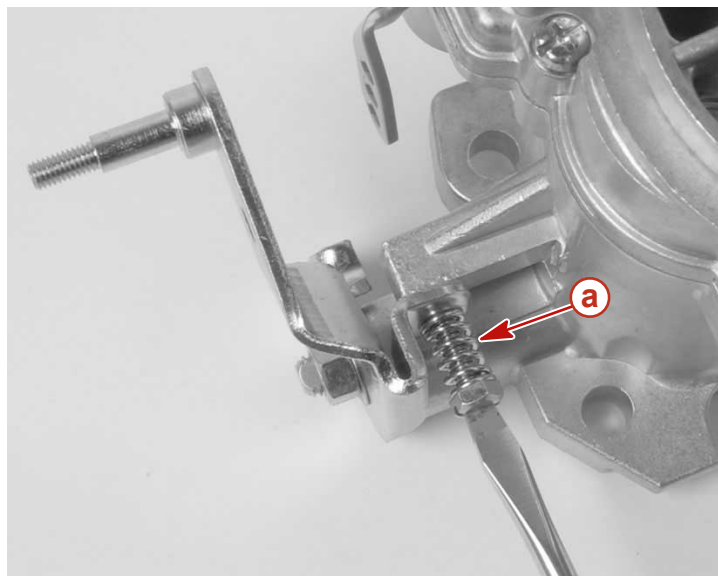


a - Idle mixture adjusting needle

9557

Idle Mixture Adjusting Tool	91-866201
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2. Thread the idle speed adjustment screw and spring into the throttle lever, and adjust to specification.



a - Idle speed screw and spring

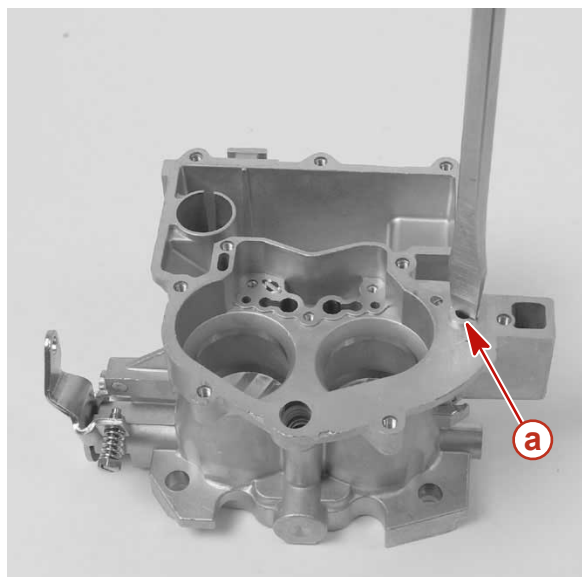
9558

Idle Mixture Adjusting Screw	91-866201
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Float Bowl

IMPORTANT: Place the float bowl and throttle assemblies in the holding fixture to prevent the throttle valves from being damaged.

1. Install the emulsion tube.

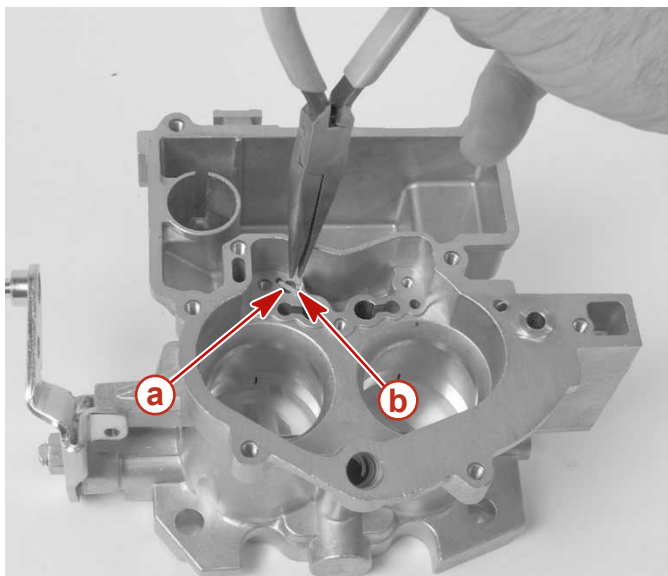


Gen 1 carburetor shown

a - Emulsion tube

9885

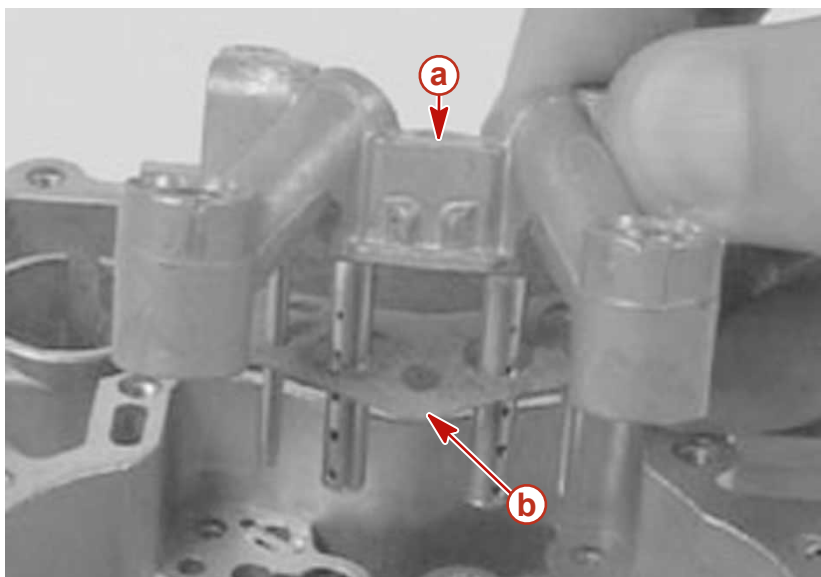
2. Install the check ball, spring, and retainer in the passage. Push the retainer firmly into the slots.



- a** - Spring retainer
- b** - Spring and check ball (not shown)

9556

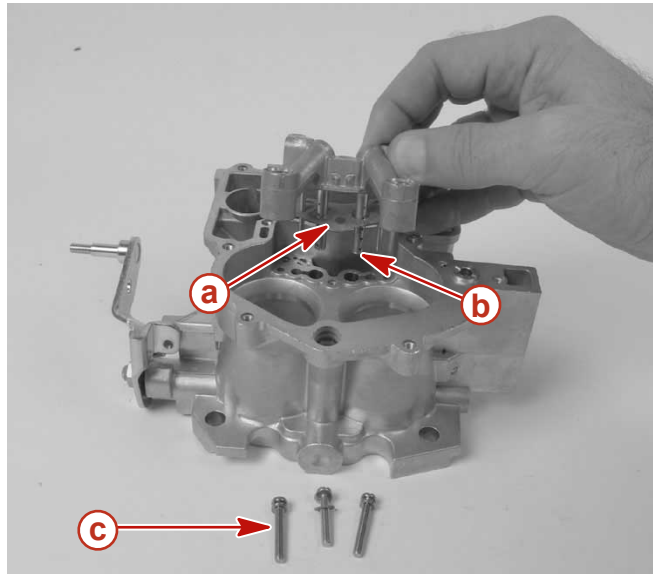
3. Install the new gasket on the venturi cluster.



- a** - Venturi cluster
- b** - Gasket

9563

4. Install the venturi cluster into the carburetor.

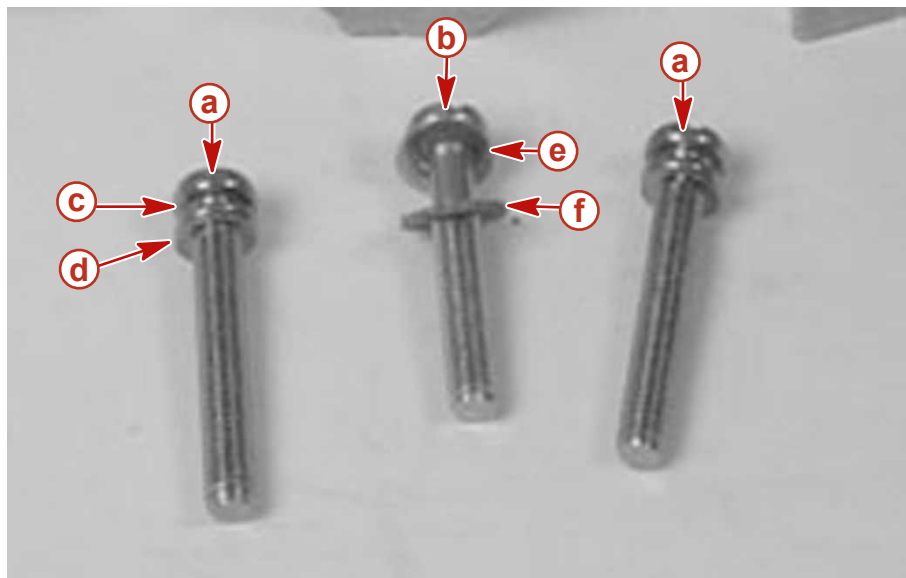


- a** - Venturi cluster brass tubes
- b** - Gasket
- c** - Screws

9555

5. Install the flat washer and new fiber washer on the center screw. Lockwashers and flat washers are used on the outer screws. Tighten screws evenly and securely.

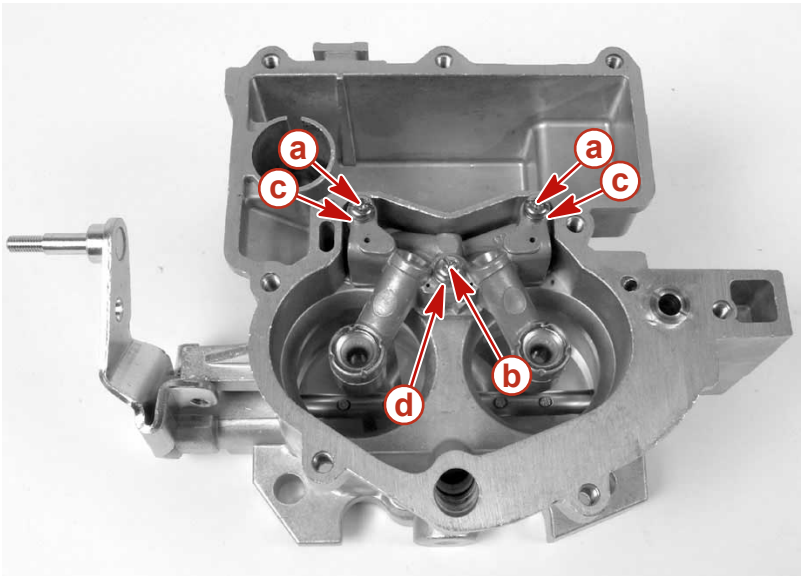
IMPORTANT: Do not damage the fiber washer. A damaged washer will cause improper engine operation.



- a** - Outer screws
- b** - Center screw
- c** - Flat washer
- d** - Lockwasher (both sides)
- e** - Flat washer
- f** - Fiber washer

9565

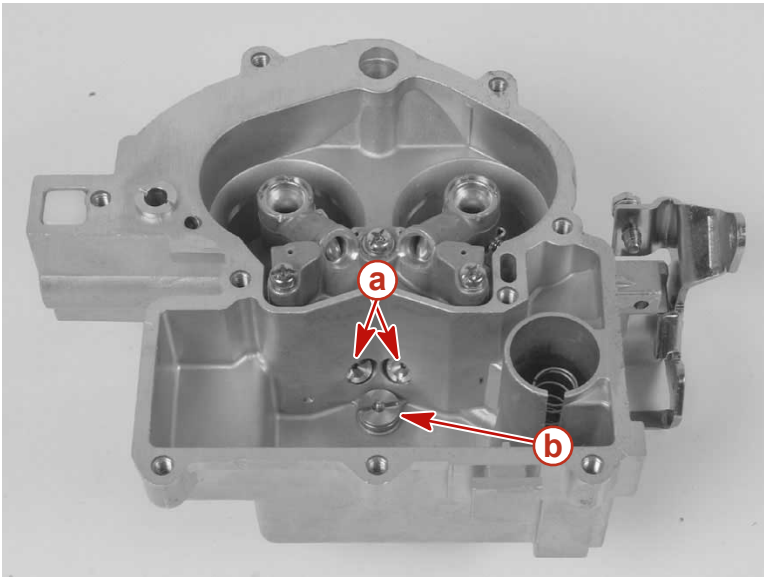
6. Ensure the venturi screws are in the proper locations with the proper washers and lockwashers.



- a - Outer screws
- b - Center screw
- c - Flat washer and lockwasher (not visible)
- d - Flat washer and fiber washer (not visible)

10026

7. **Gen 1:** Install the main metering jets and tighten to the specified torque.

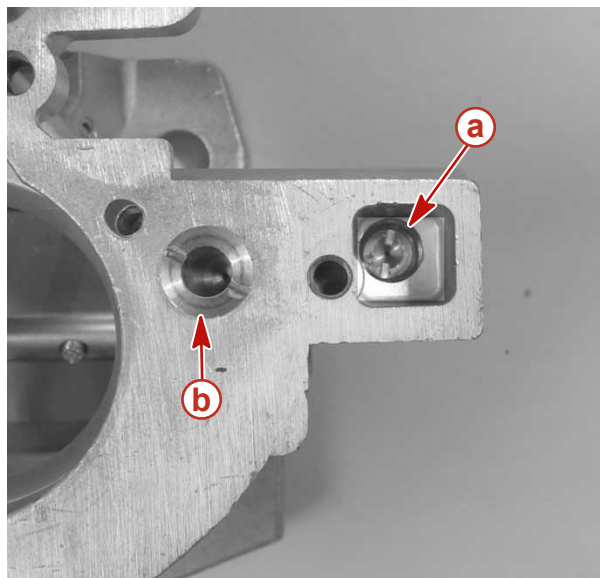


- Gen 1 float bowl**
- a - Main jets
 - b - Power valve

9669

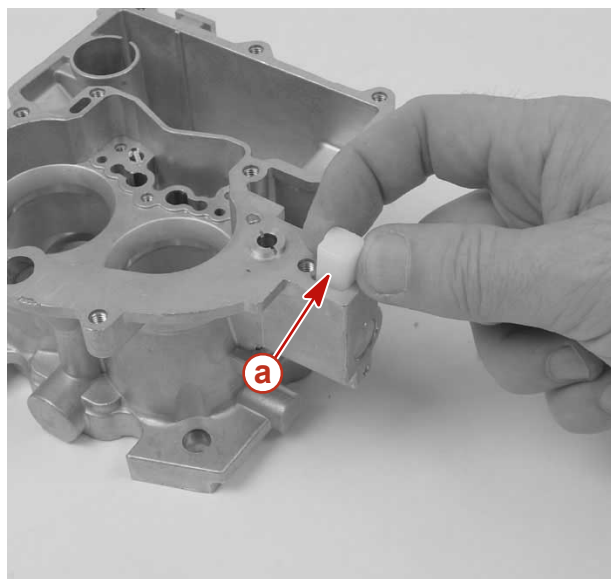
Description	Nm	lb-in.	lb-ft
Main metering jets	1.0–2.9	8.85–25.67	0.74–2.14

8. Install the TKS fuel enrichment jet at the bottom of the well and tighten securely.



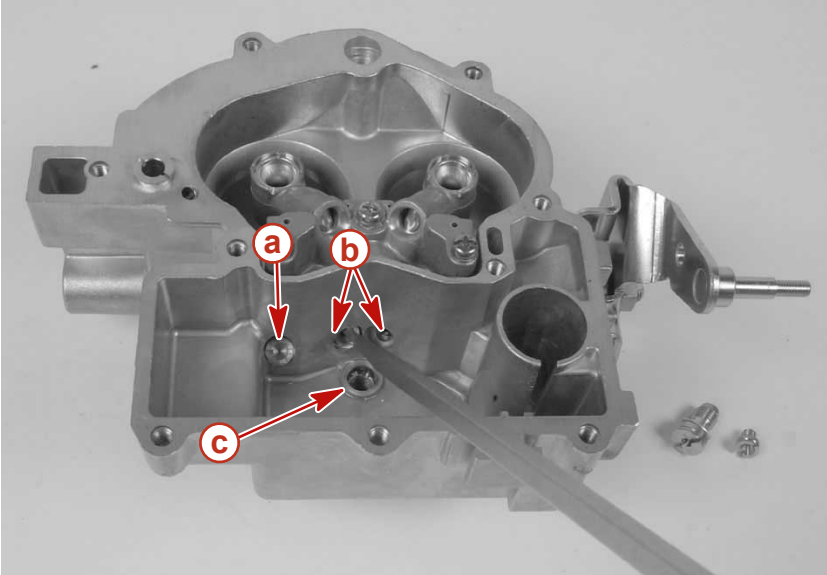
9884

9. Install the volume reduction plug. Note relief in one side to go around the screw hole.



9883

10. **Gen 2:** Install the main metering jets and tighten to the specified torque.

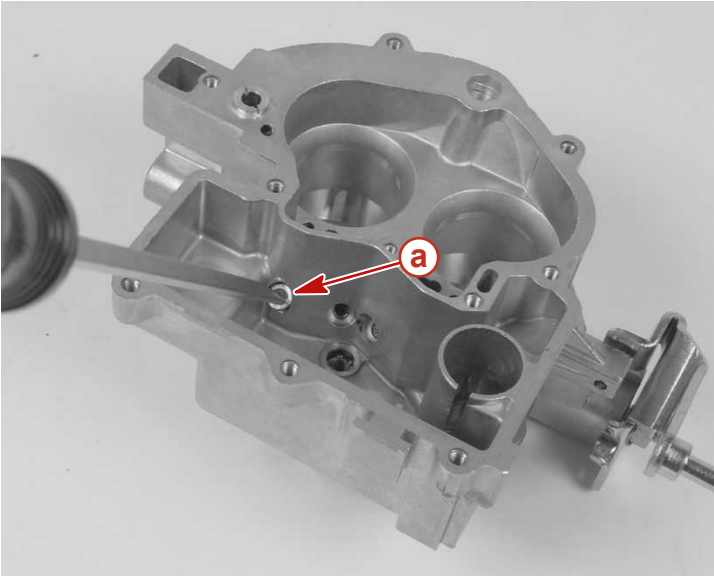


- Gen 2 float bowl**
- a -** TKS fuel enrichment jet
 - b -** Main jets
 - c -** Power valve port

Description	Nm	lb-in.	lb-ft
Main metering jets	1.0–2.9	8.85–25.67	0.74–2.14

IMPORTANT: Use care when removing the venturi cluster to prevent damaging the brass tubes which protrude from the bottom of the cluster. Do not remove the tubes. These tubes are permanently pressed into the venturi cluster and are not replaceable.

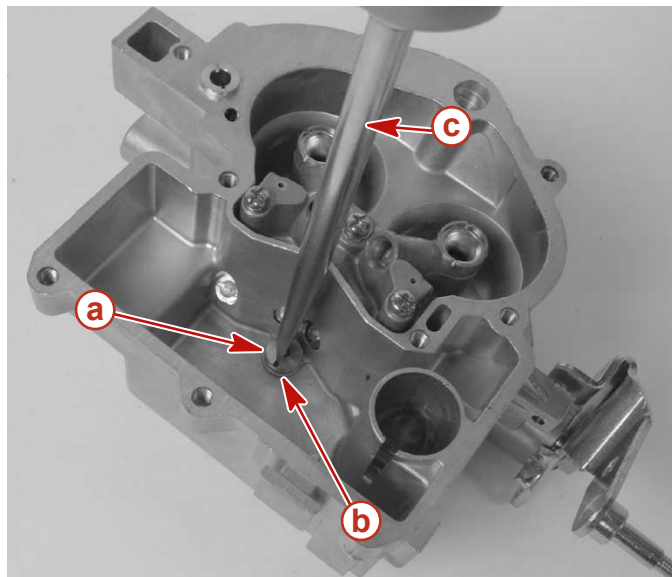
11. Install the TKS enrichment jet and tighten securely.



- a -** TKS enrichment jet

12. Install the power valve with a new gasket and tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Power valve	3.0–6.8	26.55–60.19	2.21–5.0

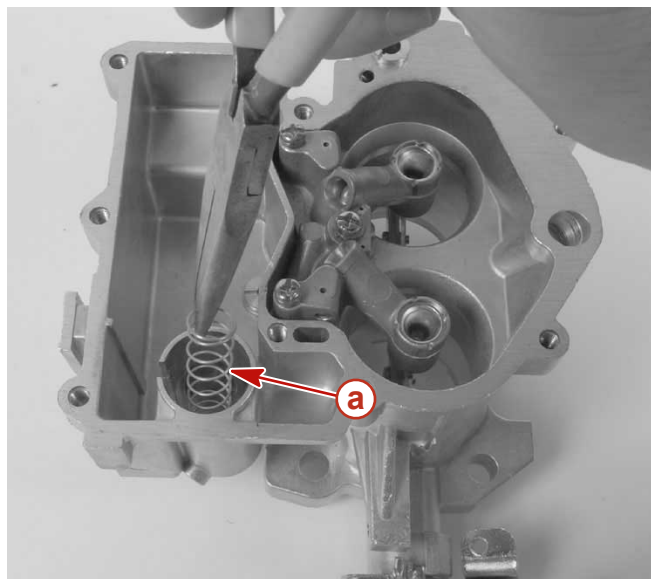


9553

Gen 2 carburetor shown

- a -** Power valve assembly
- b -** Gasket (not shown)
- c -** Screwdriver

13. Place the accelerator pump return spring in the pump well.



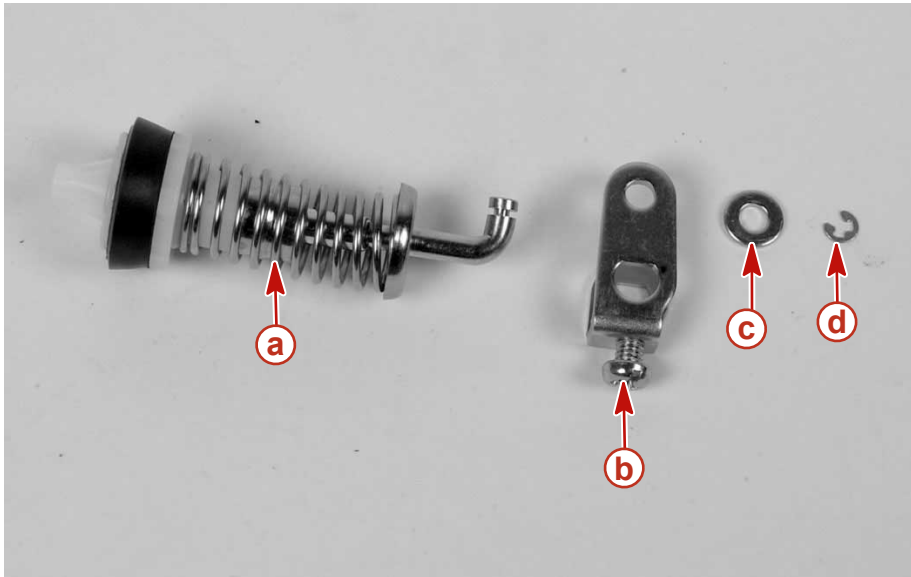
9552

- a -** Accelerator pump return spring

Air Horn

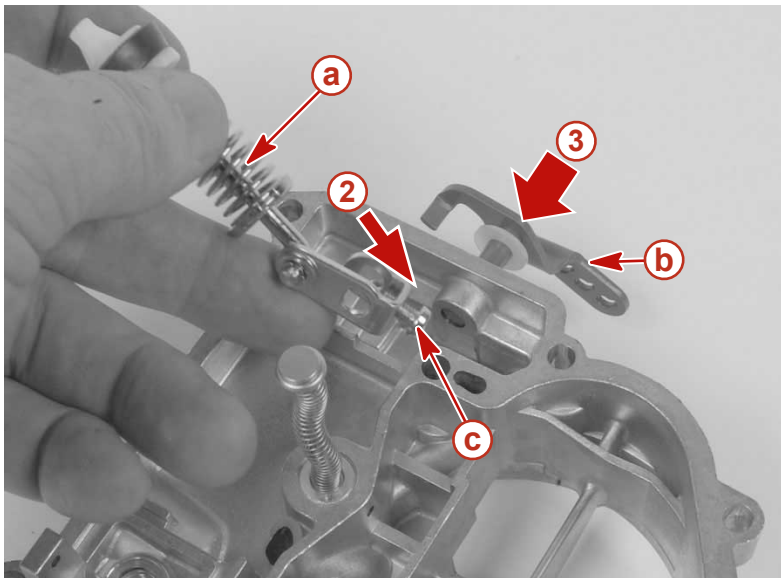
IMPORTANT: The accelerator pump assembly must be installed correctly. If the pump assembly is installed incorrectly, the top of the pump assembly will contact the air horn casting.

1. If the accelerator pump assembly was removed from the pump lever, secure the pump assembly to the pump lever with the washer and retainer clip.



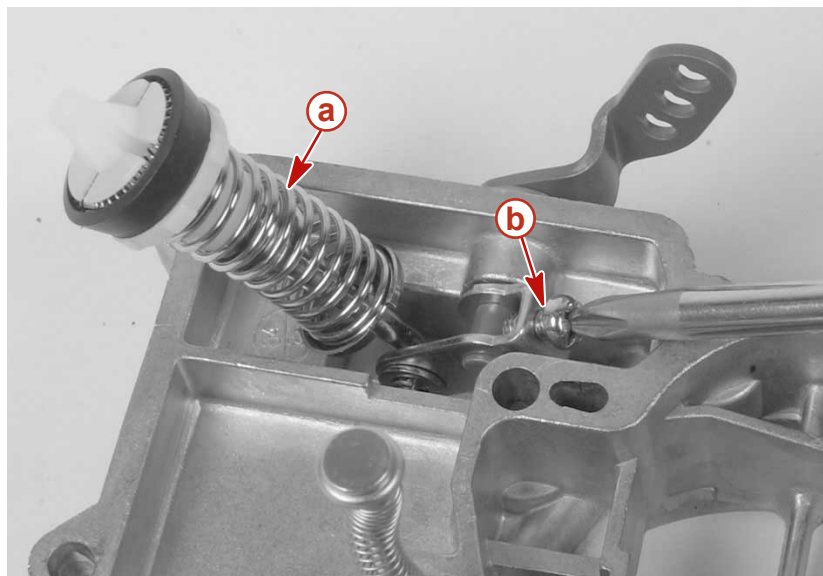
9551

2. Insert the pump shaft and lever assembly (and washer) into the air horn.
3. Align indexed hole in the pump lever with the shaft and lever assembly and slide the shaft all the way into the lever so that the shoulder on the shaft is hitting the lever.



9569

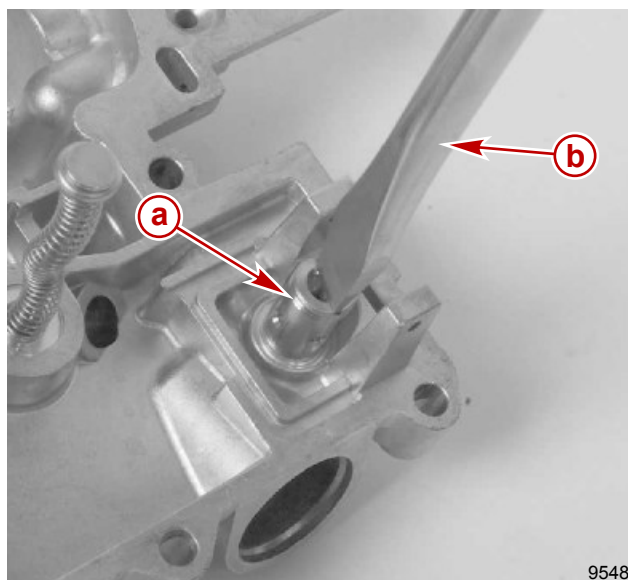
4. Tighten the set screw securely.



- a** - Pump assembly
b - Set screw

9570

5. Install the needle seat. Tighten securely.

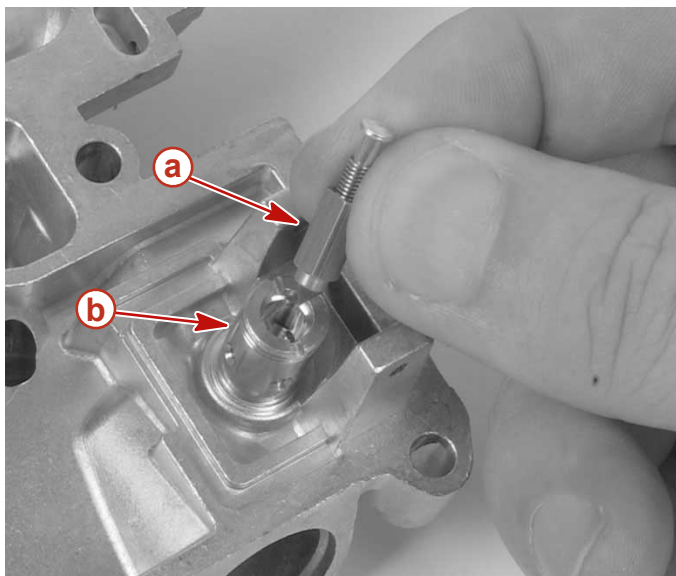


- a** - Needle seat
b - Screwdriver

9548

IMPORTANT: The float needle and needle seat are factory matched and tested and should be replaced as a set only.

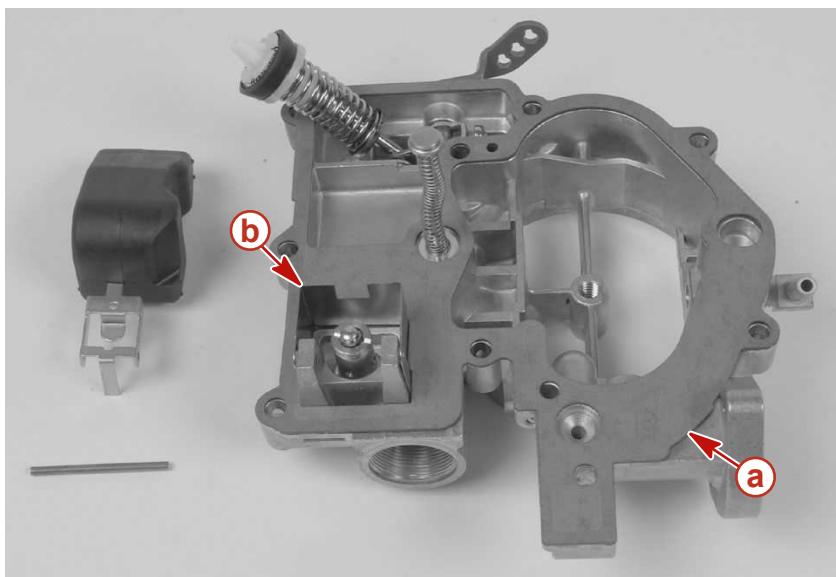
6. Place the needle assembly in the needle seat.



- a** - Needle assembly
b - Needle seat

9547

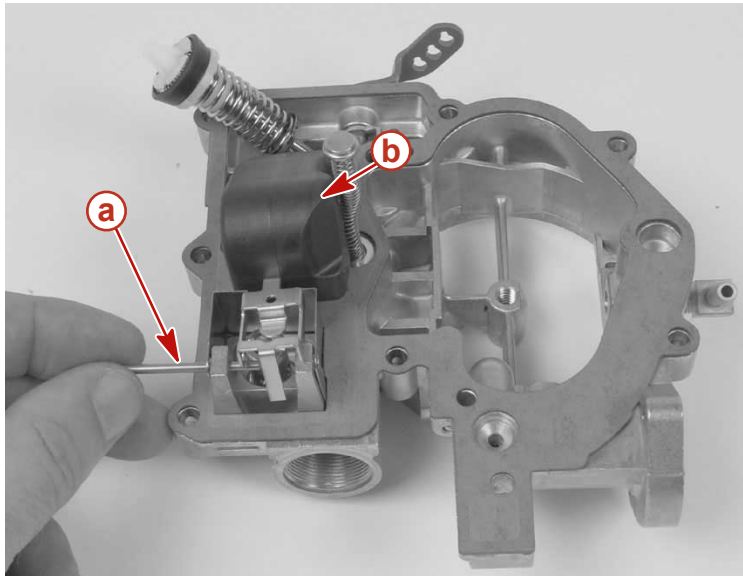
7. Install the baffle and gasket.



- a** - Airhorn gasket
b - Baffle

9546

8. Install the float assembly and hinge pin. Pivot the float assembly up and down on the hinge pin to ensure it moves freely.



- a - Float hinge pin
- b - Float assembly

9544

Float Level

1. Turn the air horn upside down. Pivot the float assembly up and down on the hinge pin to ensure it moves freely.
IMPORTANT: Before checking the float level, raise float and allow it to fall; however, do not force downward by hand.
2. Measure the float level using an universal carburetor gauge. Measure from the gasket to the dot on the toe of the float.

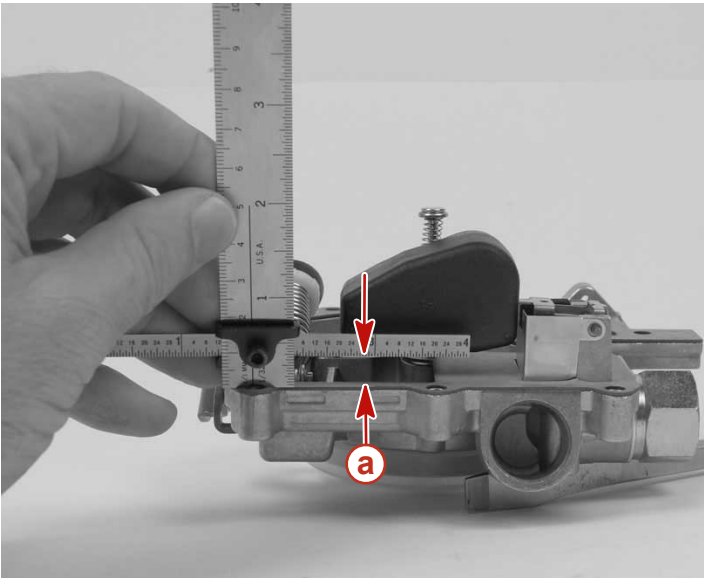


Carburetor float

- a - Measure from this point (dot) to gasket

9967

Universal Carburetor Gauge	Obtain locally
----------------------------	----------------

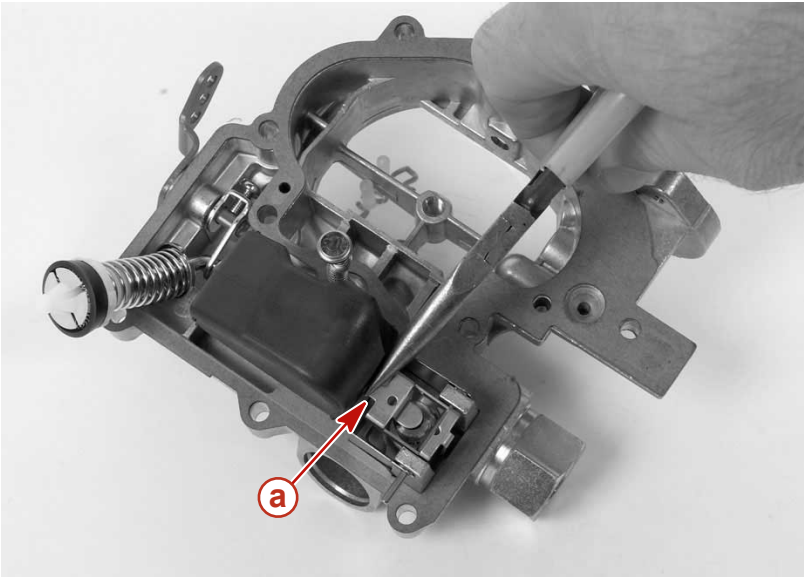


a - Measurement

9968

Needle type	Measurement
Spring loaded inlet needle float level	9 mm (11/32 in.)

3. Bend the float arm up or down at the point shown to obtain specified dimension.



a - Bend float arm at this point

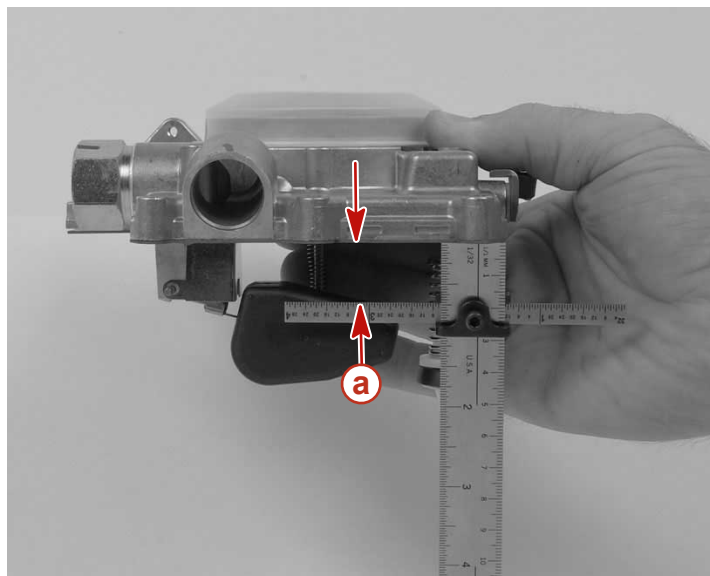
9975

4. Visually check float alignment after adjustment.

Float Drop

1. Hold the air horn right side up to allow the float to hang free.

2. Measure the float drop using an universal carburetor gauge. Measure from the gasket (air horn) to the dot on the float.

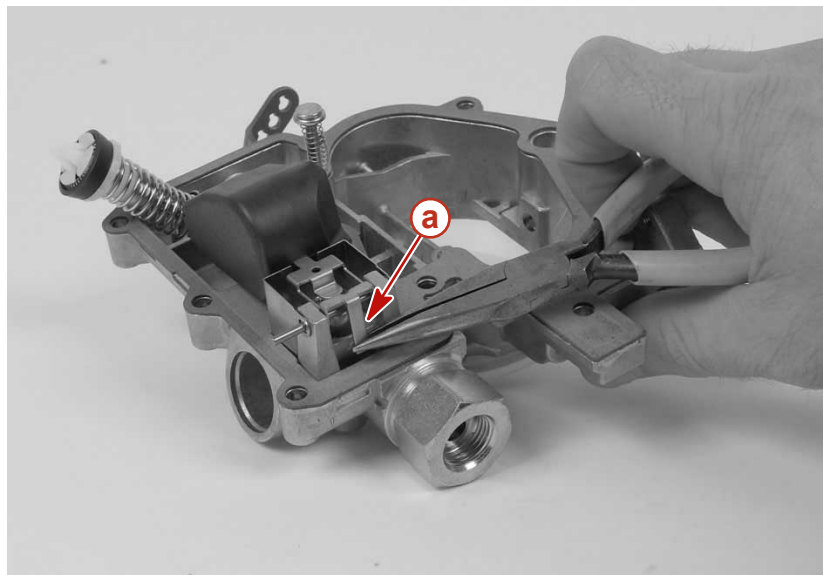


a - Measurement

9977

Needle type	Measurement
Spring loaded inlet needle float drop	24 mm (15/16 in.)
Universal Carburetor Gauge	Obtain locally

3. Bend the float assembly tang, as shown, to obtain specified dimension.

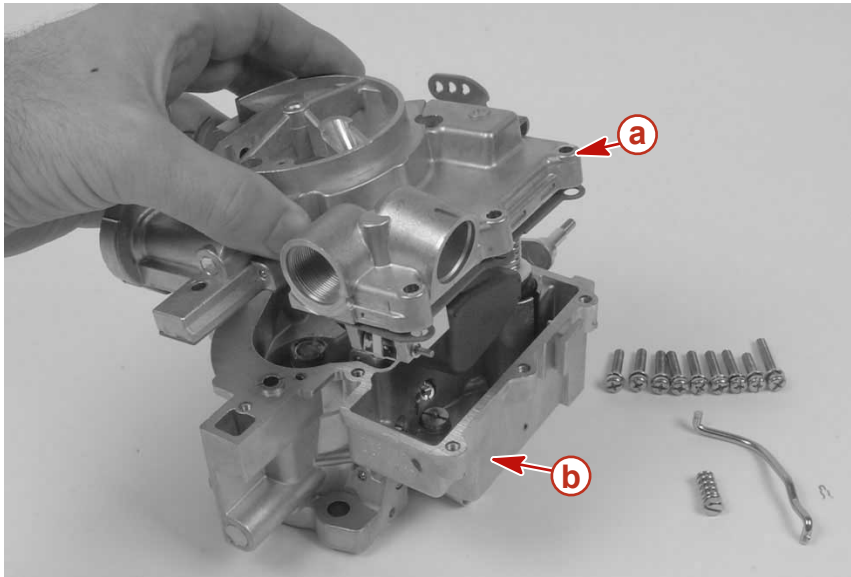


a - Float assembly tang

9978

4. Recheck both the float level and the float drop.

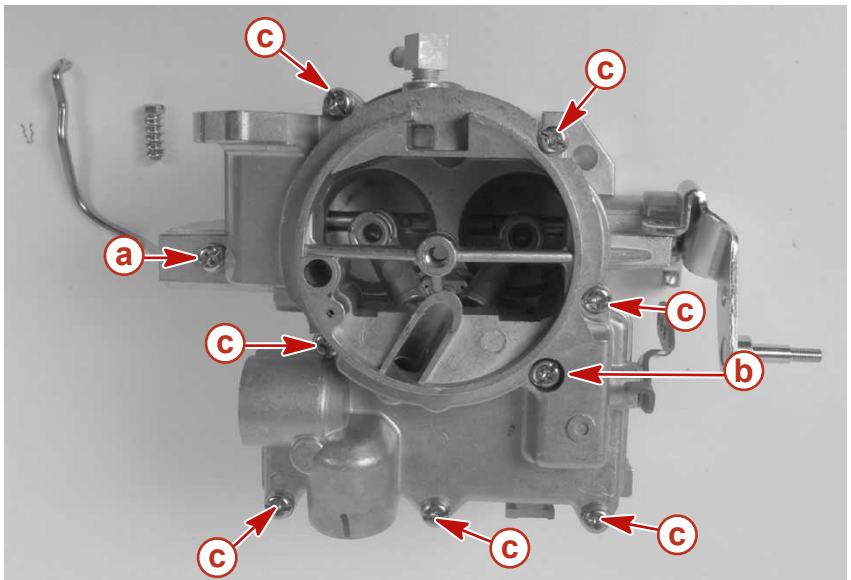
5. Place the air horn on the float bowl, making sure the accelerator pump is correctly positioned in the fuel well. Lower the air horn straight down to install.



- a - Air horn assembly
- b - Float bowl assembly

9543

6. Install the air horn using seven medium, one short, and one long attaching screw as indicated below. Tighten the screws to the specified torque.

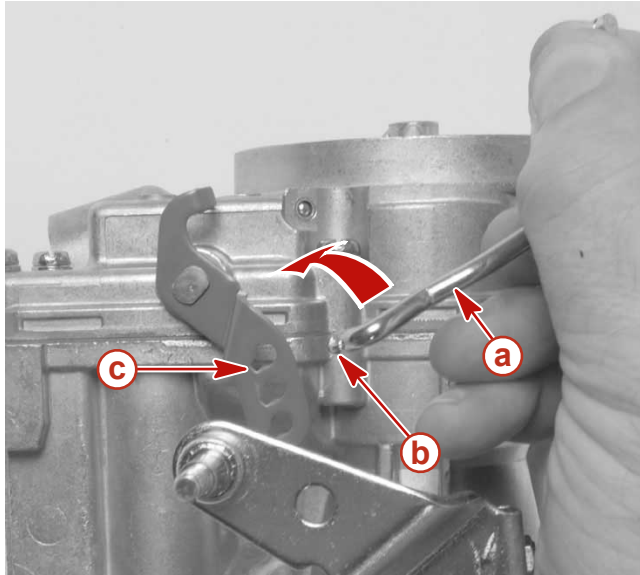


- a - Short screw (Gen 1 only) - 5M x 22 mm
- b - Long screw - 5M x 32 mm
- c - Screws - 5M x 25 mm

9581

Description	Nm	lb-in.	lb-ft
Air horn attaching screws	3-6	27-51	-

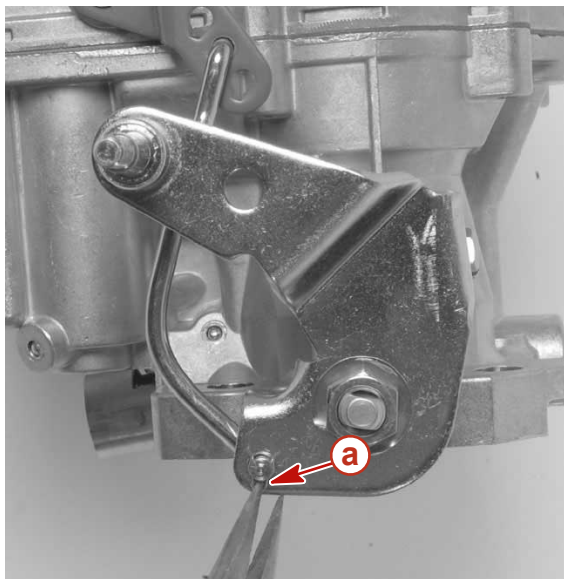
- Align the retaining ear on the rod with the slot in the accelerator pump shaft, allowing rod to be inserted. Pivot the rod around until aligned with the throttle lever hole.



- a** - Accelerator pump rod
- b** - Accelerator pump rod retaining ear
- c** - Retaining ear slot in accelerator pump shaft

9585

- Insert the other end of the accelerator pump rod into the hole in the throttle lever and secure with a retainer clip.



- a** - Retaining clip

9586

- Install the fuel inlet filter nut, washers, spring, and the filter, as outlined previously.

TKS Module

The TKS module is not a serviceable part. It is adjusted at the factory for proper performance. If the TKS module is not working properly, replace the unit.

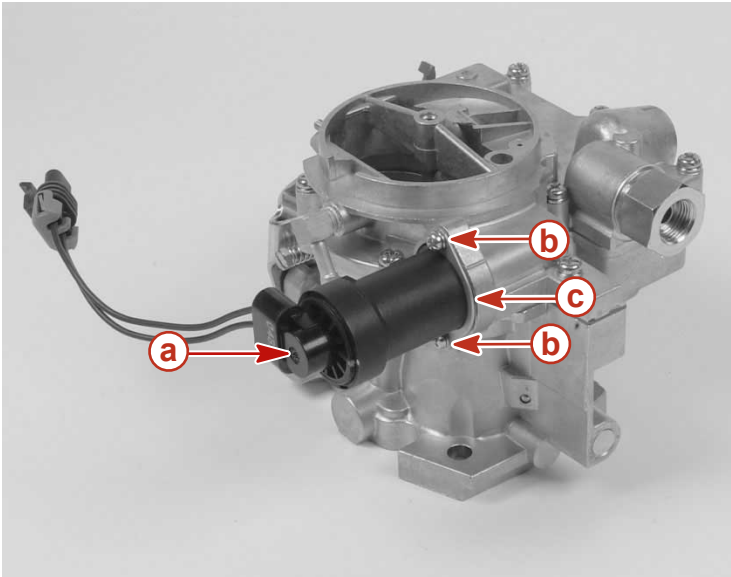
1. Insert the TKS module into the carburetor body, being careful not to damage the O-ring.



a - O-ring on TKS module

9633

2. Place the C-clip into position and tighten the screws to the specified torque. Use Loctite 242 Threadlocker on the threads.



a - TKS module
b - Screws - 4M x 10 mm
c - C-clip

9630

Description	Nm	lb-in.	lb-ft
TKS module C-clip screws	20	177	–

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	TKS module screws	92-809821

3. Refer to **Carburetor Removal and Installation** in this section for carburetor installation procedures.

Notes:

Fuel System

Section 5B - MPI Fuel Delivery Systems

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Precautions

WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

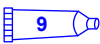
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

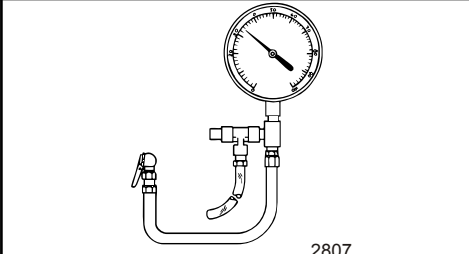
IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Threads of the fuel inlet fittings and plugs	92-809822
 66	Loctite 242 Threadlocker	TPS retaining screw threads	92-809821

Special Tools

Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS).
Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Important Information

Diagnostic Tool Kit—CDS G3

Refer to **MerCruiser Service Bulletin 2009-09** for information on CDS.

Antisiphon Valve

U.S. boating standards and regulations specify that an antisiphon valve be used on any application where any portion of the fuel line falls below the top of the fuel tank. This valve serves to minimize the amount of fuel that could leak into the bilge of the boat in the event of a fuel system leak. A mechanical antisiphon valve or an electrically operated fuel shut off valve is acceptable for this purpose and should be installed in accordance with industry standards and the manufacturer's instructions. The mechanical valve must be carefully sized to the fuel pressure head produced in a given application (a function of the fuel level height between the lowest and highest point in the system). The valve must check the flow of fuel when the engine is not running, yet avoid excessive restriction when the engine is operating. An overall fuel system pressure drop of 6.9 kPa (1 psi) or less is desirable but may not be achievable in all cases. In these cases, it is recommended that an electric fuel shut off valve be used.

Vapor locking

Under certain conditions, engines may experience a 'vapor lock' condition. Refer to **MerCruiser Service Bulletin No. 99-7, Gasoline Engine Vapor Locking**.

Low Permeation Fuel Lines

Beginning in 2007 all spark-ignition marine inboard and sterndrive engines sold in California must use low permeation fuel supply and return lines to comply with applicable California Air Resources Board (CARB) regulatory standards.

Fuel Supply Components

⚠ WARNING

Failure to comply with the required boating standards can result in serious injury or death. Always adhere to all applicable Marine Regulations (United States Coast Guard [USCG], European Union - Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) when installing the fuel delivery system.

IMPORTANT: Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines.

- An antisiphon valve is required by the Coast Guard.

MPI Fuel Delivery Systems

- We recommended that an electric antisiphon valve be used, as this type of valve may help prevent vapor-locking when reformulated fuels or fuels with high reed-vapor pressure are used.
- Beginning in 2007 all spark-ignition marine inboard and sterndrive engines sold in California must use low permeation fuel supply and return lines to comply with applicable California Air Resources Board (CARB) regulatory standards. Low permeation fuel line hose is defined as not exceeding 15 g/m²/24 h with CE10 fuel at 23 °C as specified in SAE J 1527–marine fuel hoses.
- Flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.
- Fuel lines and fittings must be Coast Guard approved (USCG type A1), and not be smaller than 10 mm (3/8 in.) I.D.
- Multiple engine installations: It is best to use a fuel pickup and supply line for each engine. If a single pickup and supply line is used, fittings and line must not be smaller than 13 mm (½ in.) I.D.
- Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
- The tank breather pipe must have an inner diameter of at least 13 mm (½ in.) and must be fitted with a swan neck to prevent water from entering the tank.
- The filler pipe outer diameter should be at least 50 mm (2 in.).
- All connections should be on the upper side of the tank.
- A drain plug at the lowest point on the tank will permit removal of water and sediment.
- Establish the exact route and length of the fuel lines at the first installation of the engine to prevent problems later in connecting them to the engine.
- To prevent chafing, holes where the lines run through the bulkheads should be rounded off or protected with rubber grommets and fuel lines must be well secured.
- Fuel pickup should be at least 25 mm (1 in.) from the fuel tank bottom to prevent picking up impurities.
- The maximum measured vacuum at the engine's fuel inlet must not exceed 2 in. Hg or 6.9 kPa (1 psi) at idle, 3000 RPM, and full throttle RPM.

Special Information About Electric Fuel Pumps

IMPORTANT: The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional water separating fuel filters between the fuel tank and the engine. Use a Mercury in-line fuel filter and boost pump if necessary.

The installation of additional filters may cause:

- Vapor lock
- Difficult warm-starting
- Piston detonation due to lean fuel mixture
- Poor driveability

Fuel Supply Connections

WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

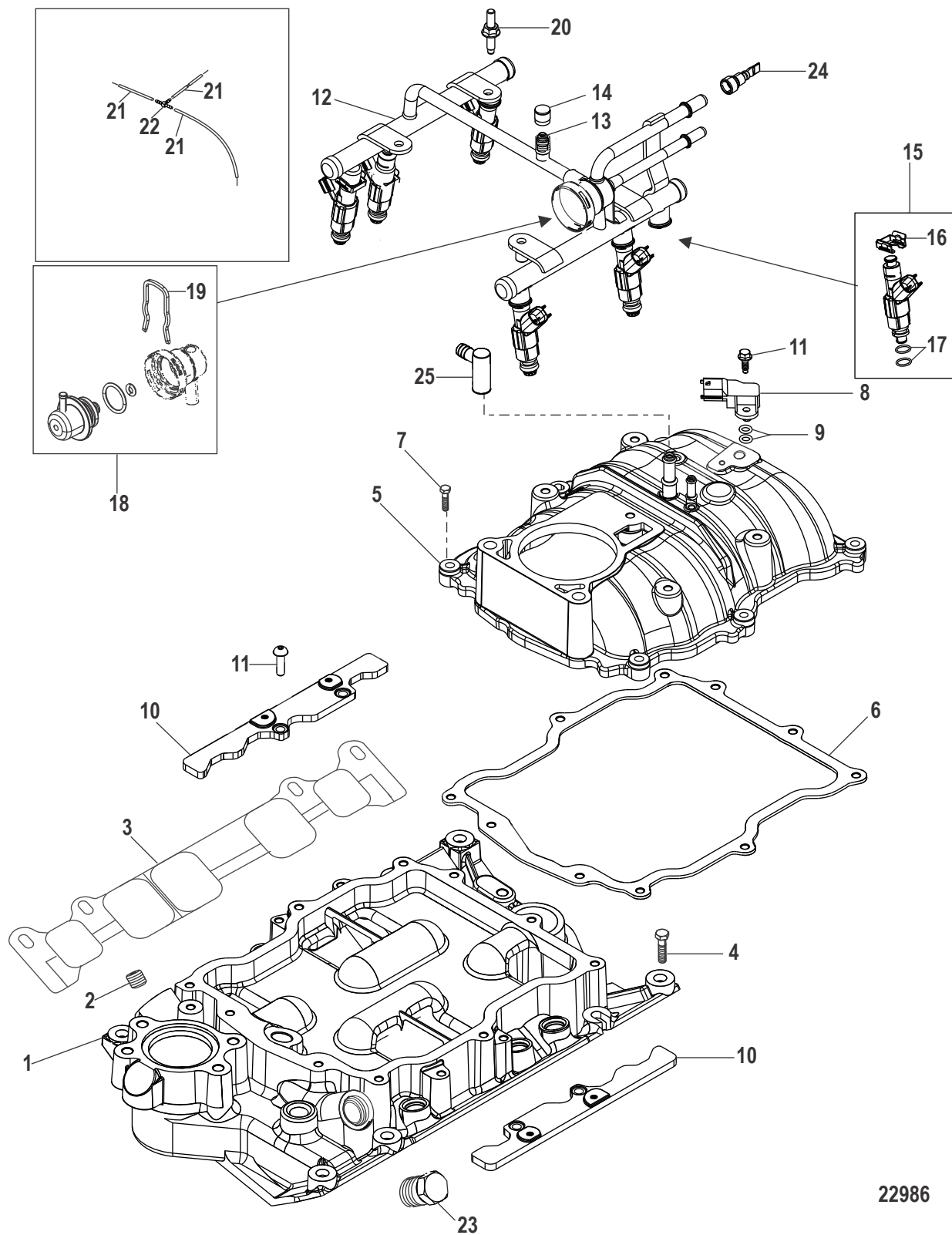
- Use Loctite 567 PST Pipe Sealant on the threads of the fuel inlet fittings or plugs. **Do not use PTFE tape.**

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Threads of the fuel inlet fittings and plugs	92-809822

- Fuel inlet fittings or plugs should first be threaded into the fuel pump or fuel filter base by hand until finger-tight.
- Fuel inlet fittings or plugs should then be tightened an additional 1-3/4 to 2-1/4 turns using a wrench. **Do not overtighten.**
- To prevent fitting damage or overtightening when installing a fuel line, counter hold both fittings with a suitable wrench as they are tightened.

Notes:

Intake Manifold and Fuel Rail



22986

Intake Manifold and Fuel Rail

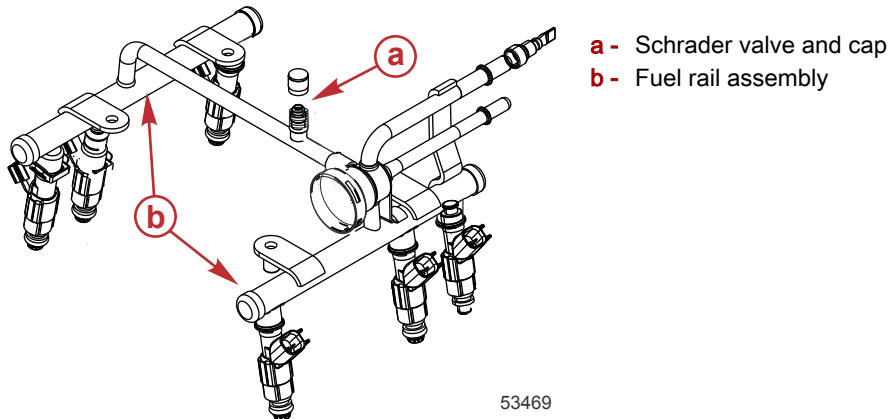
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Lower intake manifold			
2	1	Brass plug			
3	1	Lower intake manifold gasket set			
4	8	Screw	First	26.5	–
			Second	106	–
			Final	–	18
5	1	Upper intake manifold			
6	1	Intake manifold gasket			
7	8	Screw	First	44	–
			Final	89	–
8	1	Manifold absolute pressure and temperature (MAPT) sensor			
9	2	Seal			
10	1	Bracket			
11	4	Screw	6	53	–
12	1	Fuel rail assembly			
13	1	Fuel pressure Schrader valve			
14	1	Fuel pressure Schrader valve cap			
15	6	Fuel injector			
16	1	Injector retainer			
17	1	O-ring kit			
18	1	Fuel pressure regulator			
19	1	Clip			
20	4	Screw			
21	3	Hose			
22	1	T-fitting			
23	1	Pipe plug (seawater cooling)			
23	1	Connector barb (closed cooling)			
24	1	Fuel rail block off plug			
25	2	90° fitting			

Fuel Pressure Relief

IMPORTANT: Pressure venting the fuel system will result in the release of fuel in both a liquid and vapor state. Take all appropriate safety precautions, including proper personal protection, venting, and collection procedures.

- 1. Remove the engine cover.
- 2. Attach an appropriate tool, such as a fuel pressure gauge with a flexible line and vent valve, to the Schrader valve located on the fuel rail crossover tube.

Digital Pressure Meter	91-892651A01
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Fuel Pressure Test

- 1. Remove the Schrader valve cap from the fuel rail and install a fuel pressure gauge onto the fuel pressure Schrader valve.

Fuel Pressure Gauge Kit	91-881833A03
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- 2. Start the engine.
 - 3. Temporarily remove the vacuum hose at the intake from the fuel pressure regulator.
 - 4. Take a reading from the fuel pressure gauge. The fuel pressure should be within specification.
- NOTE:** The ambient barometric air pressure will have a direct effect on the fuel pressure reading.

Fuel Pressure Specification	
At 850 RPM	296 ± 14 kPa (43 ± 2 psi)

NOTE: Fuel pressure at idle to 850 RPM is 248–262 kPa (36–38 psi). With vacuum regulator line removed at idle should read 296 ± 14 kPa (43 ± 2 psi).

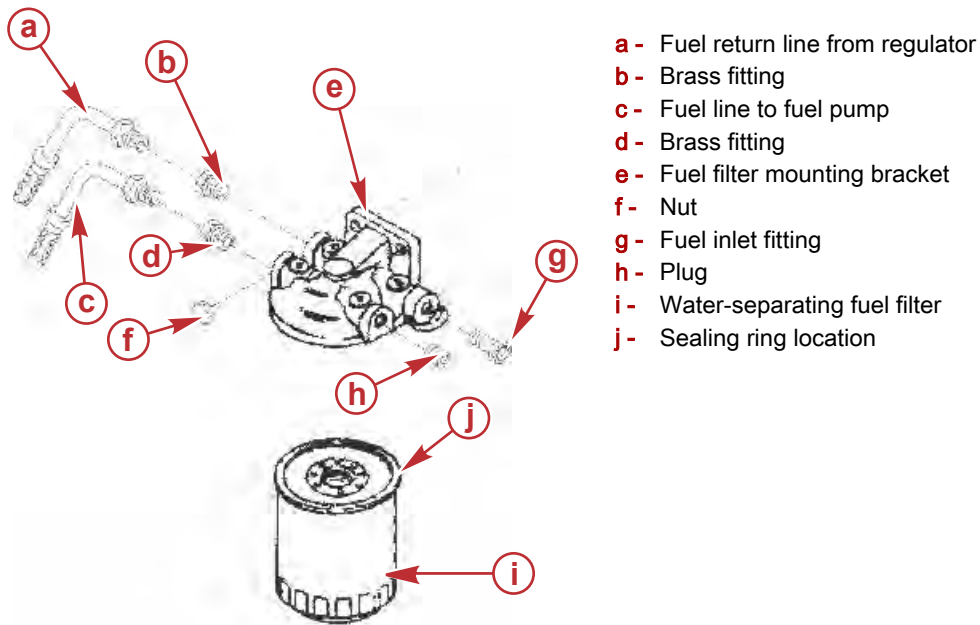
- 5. Connect the vacuum hose back to the intake. Note the pressure reading will drop.
- 6. Turn the engine off.
- 7. Remove the fuel pressure gauge and install the Schrader valve cap.

Water-Separating Fuel Filter

Removal

- 1. Disconnect the battery power.
- 2. Relieve the fuel system pressure.
- 3. Wrap the filter in a cloth to catch fuel spills.

4. Remove the water-separating fuel filter and sealing ring from the mounting bracket.

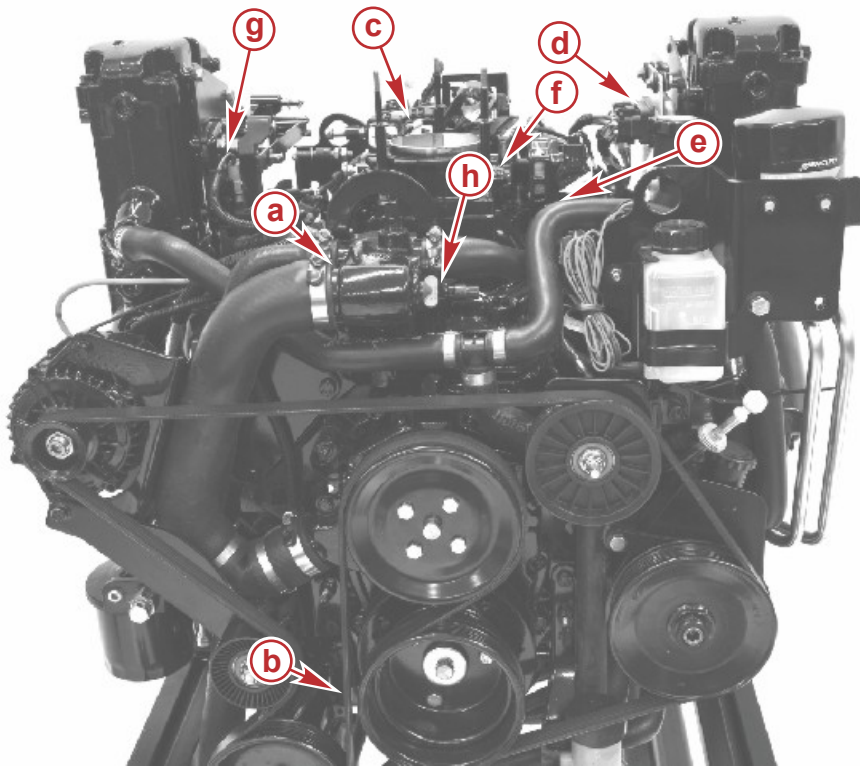


5. Discard the filter and sealing ring.

Installation

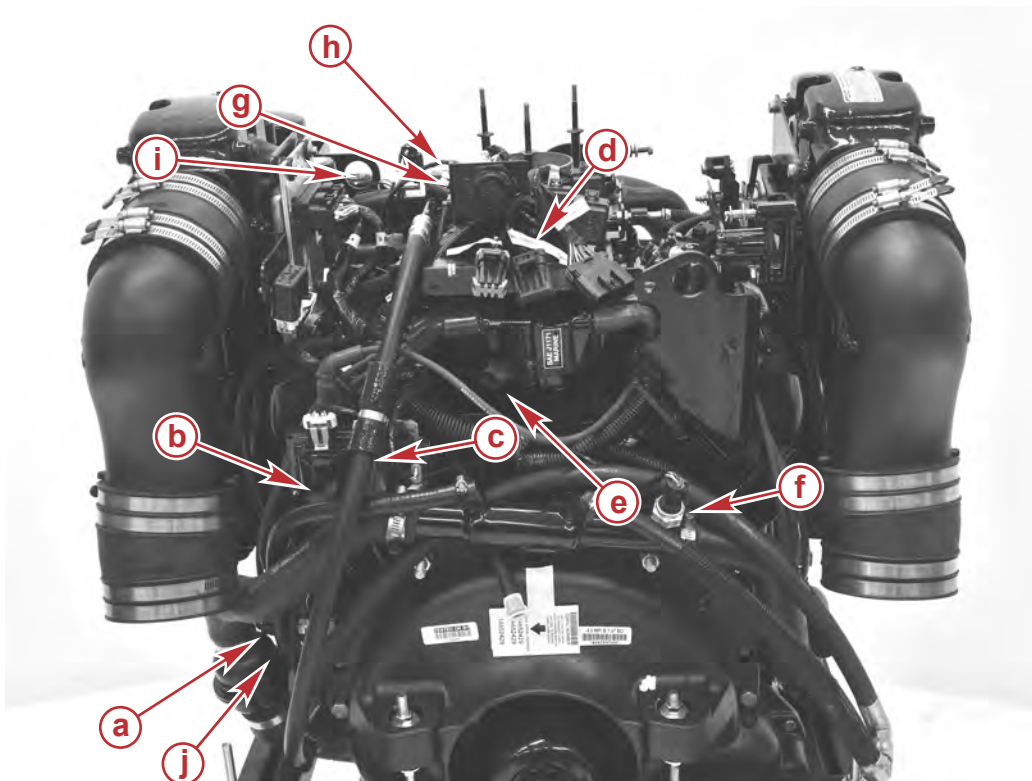
1. Lubricate the sealing ring on the new water-separating fuel filter with new engine oil.
2. Thread the water-separating fuel filter onto the bracket and tighten securely by hand. Do not use a filter wrench.
3. Supply cooling water to all water inlets.
4. Start and operate the engine. Check the connections for fuel leaks. If leaks exist, stop the engine immediately and recheck the filter installation.

Sensor and Module Locations



- a** - Water temperature sender
- b** - Crank position sensor
- c** - Relays
- d** - ECM
- e** - Idle air control (IAC)
- f** - Throttle position sensor (TPS)
- g** - Shift bracket
- h** - Engine coolant temperature (ECT) sensor

52696



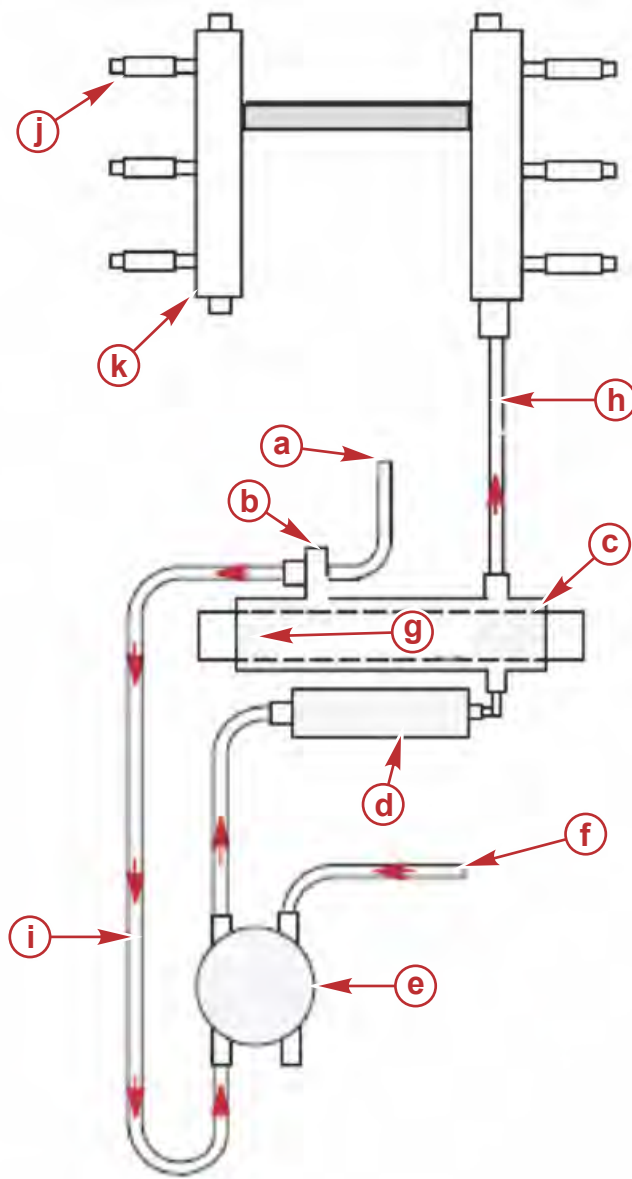
52697

- a** - Cool fuel harness connector
- b** - Ignition coil
- c** - Coil driver module
- d** - Manifold absolute pressure and temperature (MAPT) sensor
- e** - HVS distributor connector (capped)
- f** - Sea pump pressure sensor
- g** - Circuit breaker (50 amp)
- h** - Idle air control (IAC)
- i** - MerCathode controller
- j** - Oil pressure sender

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

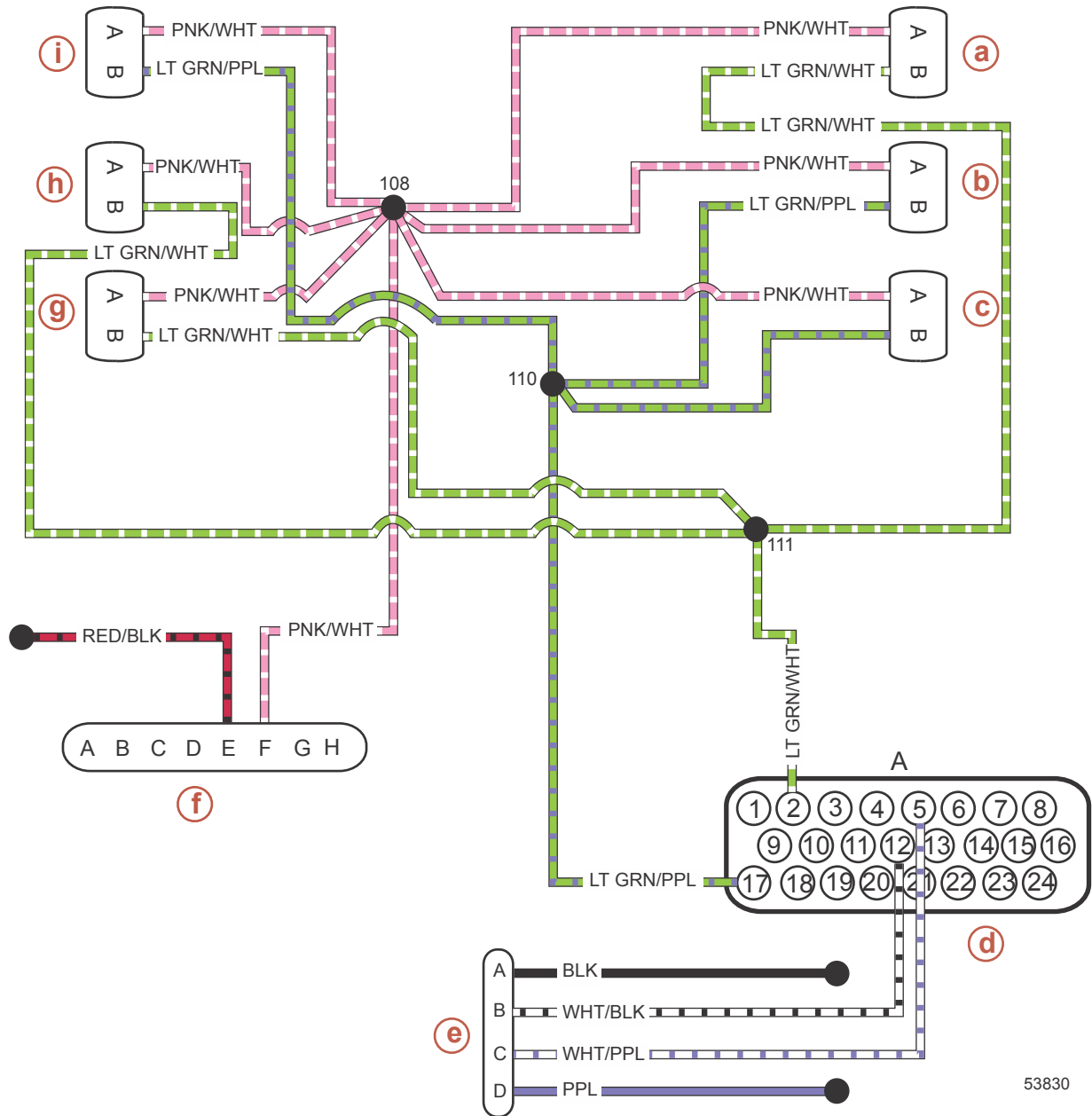
MPI Fuel System Flow Diagram



- a** - Vacuum line to intake manifold from fuel pressure regulator
- b** - Fuel pressure regulator
- c** - Fuel cooler
- d** - Electric fuel pump
- e** - Water separating fuel filter
- f** - Fuel from tank
- g** - Water flow
- h** - Fuel line to fuel rail
- i** - Excess fuel return to water separating fuel filter
- j** - Fuel injector (6)
- k** - Fuel rail

52690

MPI Fuel Injector Control Circuit



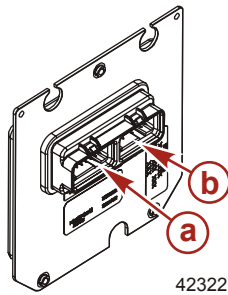
53830

- a** - Injector 2
- b** - Injector 3
- c** - Injector 5
- d** - ECM 555 connector A
- e** - Diagnostic connector
- f** - Fuse holder
- g** - Injector 6
- h** - Injector 4
- i** - Injector 1

Electronic Control Module (ECM 555)

Electronic Control Module (ECM)

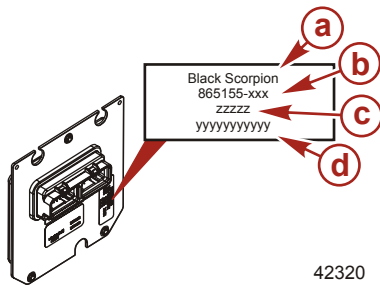
IMPORTANT: The ECM is a sensitive electrical device subject to electrostatic damage. Do not touch the connector pins when removing or installing the module.



- a - ECM connector "A" pins
- b - ECM connector "B" pins

ECM Calibration Label

The ECM calibration label includes information indicating the software calibration version. Each ECM calibration is drive specific. It is important to have this information available before calling Customer Service.



- a - Engine model
- b - Calibration part number
- c - Base module part number
- d - Detailed calibration ID, with model year

NOTE: The decal should not be trusted for the latest calibration information. Tech should use CDS and check for calibration information in the systems information.

ECM Removal

⚠ WARNING

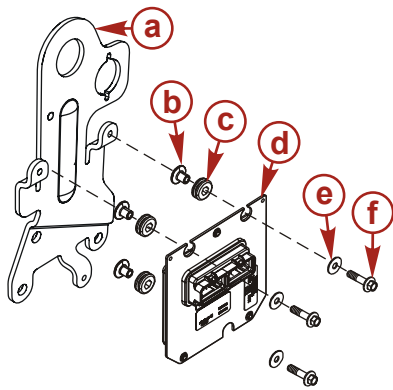
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

1. Ensure the battery cables are disconnected.
2. Disconnect the electrical connectors at the ECM.
3. Remove the ECM from the electrical bracket.

NOTE: Do not touch the connector pins.



- a** - ECM mounting bracket and engine lifting eye
- b** - Bushing
- c** - Grommet
- d** - ECM
- e** - Washer
- f** - Screw

42323

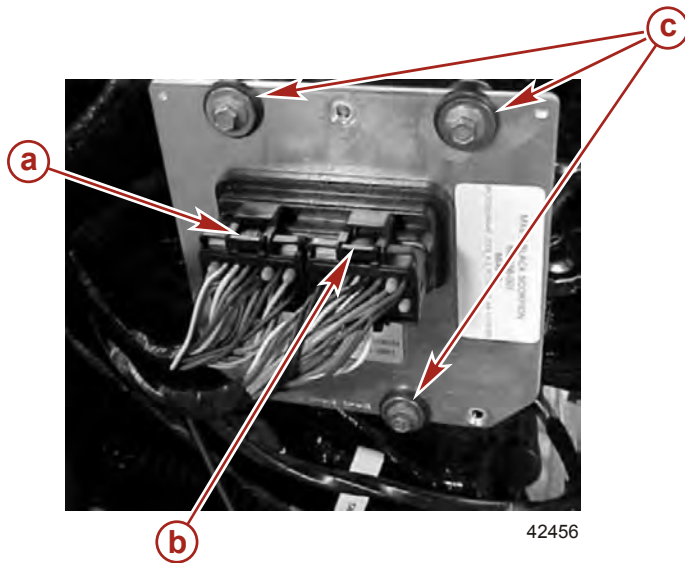
ECM Cleaning and Inspection

NOTE: The ECM is a sealed electrical component. If it is defective, replace the ECM.

1. Clean the exterior of the ECM with a dry cloth. Do not touch the connector pins.
2. Inspect the outer surface for any obvious damage.
3. Visually inspect the electrical pins at both ends of the ECM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

ECM Installation

1. Mount the ECM to the bracket using screws and washers.
2. Connect and lock the electrical connectors to the ECM. Do not touch the connector pins.



- a** - ECM connector "A"
- b** - ECM connector "B"
- c** - Fasteners

42456

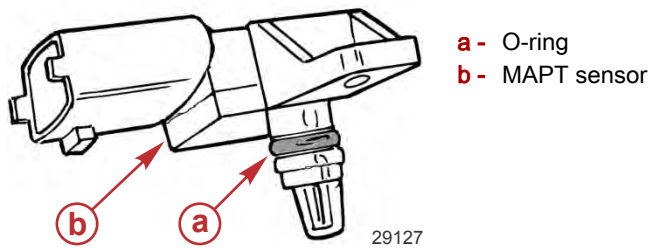
Sensors

Manifold Absolute Pressure and Temperature (MAPT) Sensor

Removal

1. Disconnect the harness connector from the MAPT sensor.

- 2. Remove the MAPT sensor from the upper intake manifold and discard the O-ring seal.



Cleaning and Inspection

- 1. Clean the surfaces of the MAPT sensor with a dry cloth.
- 2. Inspect the MAPT sensor for signs of wear or damage.

Installation

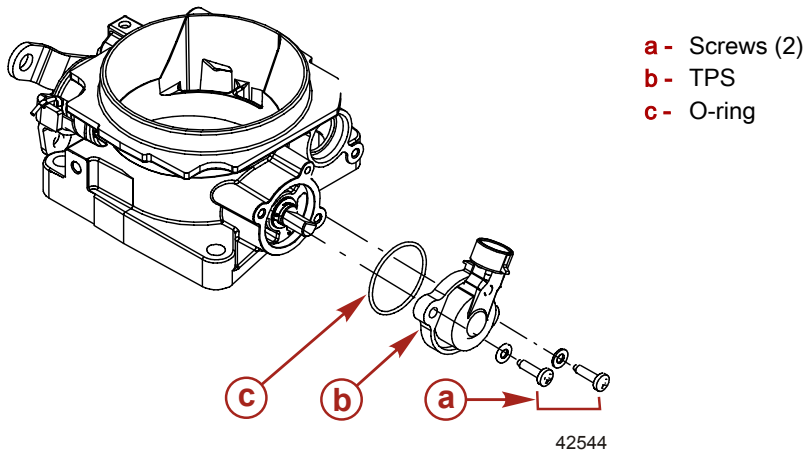
- 1. Install a new MAPT sensor seal onto the MAPT sensor.
- 2. Apply one drop of clean engine oil to the MAPT sensor seal.
- 3. Install the MAPT sensor into the upper intake manifold and tighten the retaining screw to specification.

Description	Nm	lb-in.	lb-ft
MAPT retaining screw	6	53	–

- 4. Connect the MAPT sensor electrical connector.

Throttle Position Sensor (TPS)

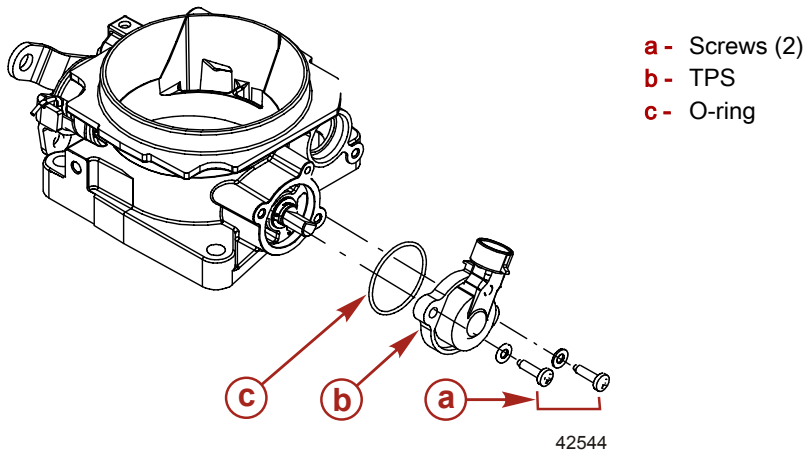
- 1. Removal:
 - a. Remove the engine cover and flame arrestor.
 - b. Disconnect the TPS harness connector.
 - c. Remove the screws from the TPS.
 - d. Remove the TPS from the throttle body.



- 2. Cleaning and inspection:
 - a. Clean the surfaces of the TPS with a dry cloth.
 - b. Inspect the TPS for signs of wear or damage.
- 3. Installation:
 - a. Install a new O-ring onto the TPS.
 - b. Apply Loctite 242 Threadlocker to the threads of the TPS retaining screws.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	TPS retaining screw threads	92-809821

- c. Insert the TPS into the throttle body.



- d. Install and tighten the TPS retaining screws to the specified torque.

Description	Nm	lb-in.	lb-ft
TPS retaining screws	2	20	–

- e. Connect the TPS harness connector.
f. Install the flame arrestor and engine cover.

Description	Nm	lb-in.	lb-ft
Flame arrestor retainer nut	12	108	–

- g. Reconnect the battery cables.
h. Start the engine and check the TPS output voltage and compare to specification.

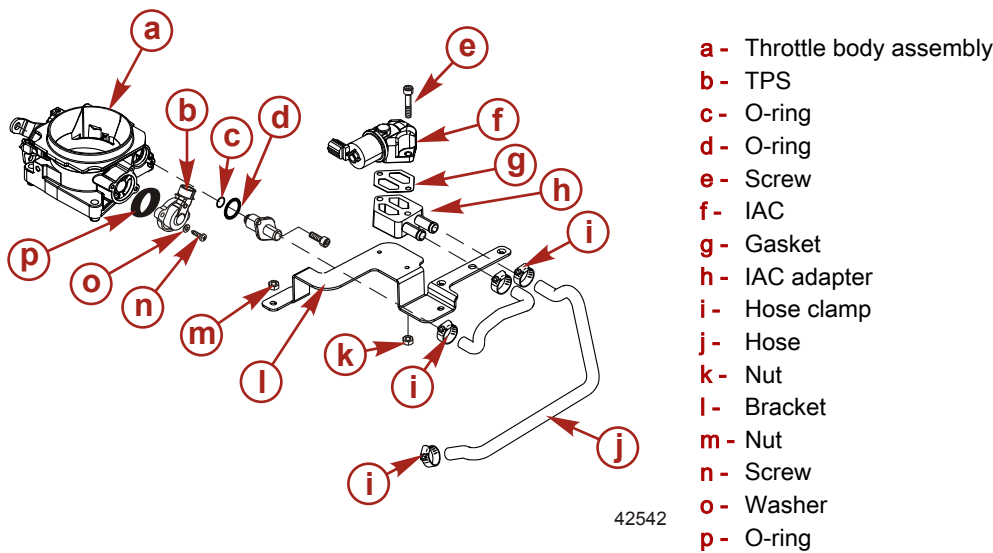
Description	Specification
TPS output voltage at idle	0.7 V
TPS output voltage at WOT	4.5 V

Idle Air Control (IAC) Valve—10 Pin Models

Removal

1. Remove the engine cover.
2. Remove the IAC hoses.
3. Disconnect the electrical connector.
4. Remove the IAC bracket nuts.
5. Remove the IAC and bracket.

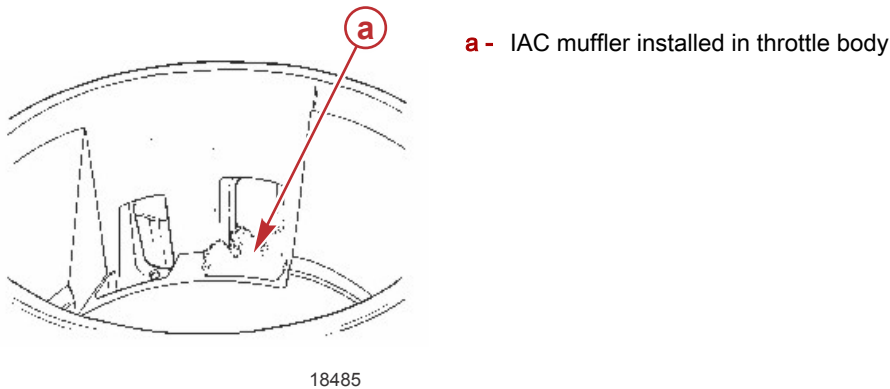
6. Remove the two screws retaining the IAC to the bracket.



Cleaning and Inspection

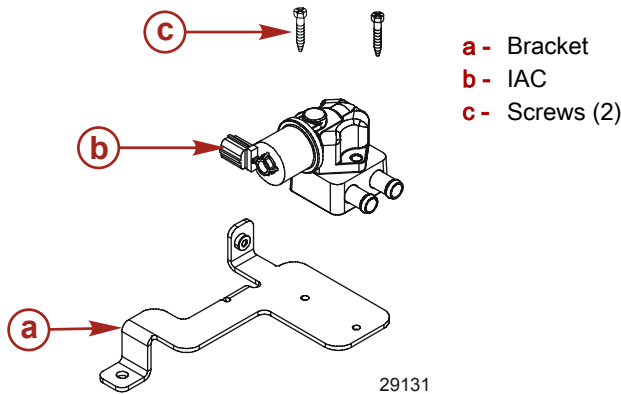
IMPORTANT: Do not use cleaners containing methyl ethyl ketone.

- 1. Clean the surfaces of the IAC with a dry cloth.
- 2. Inspect the IAC for signs of wear or damage.
- 3. Inspect the IAC muffler. If grey or black it should be replaced or cleaned.



Installation

1. Install the IAC to the bracket and tighten the screws to the specified torque.



Description	Nm	lb-in.	lb-ft
IAC bracket screws	19	168	–

2. Install the IAC and bracket assembly and tighten the nuts to the specified torque.

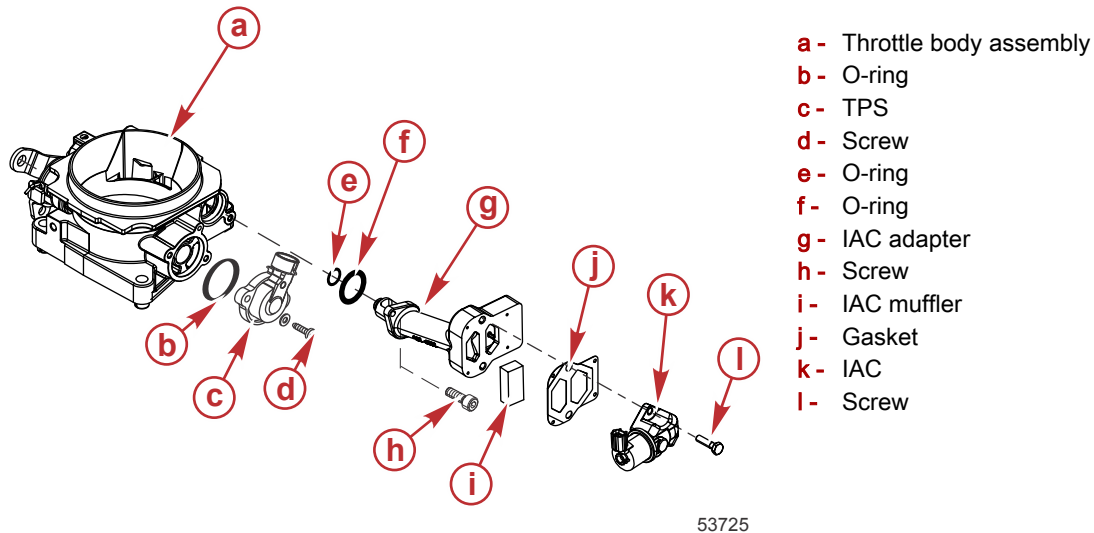
Description	Nm	lb-in.	lb-ft
IAC bracket nuts	15	133	–

3. Attach the IAC harness connector.

Idle Air Control (IAC) Valve—14 Pin Models

Removal

1. Remove the engine cover.
2. Disconnect the electrical connector.
3. Remove the two screws retaining the IAC to the IAC adapter.



Cleaning and Inspection

1. Clean the surfaces of the IAC with a dry cloth.
2. Inspect the IAC for signs of wear or damage.
3. Inspect the IAC muffler. If grey or black it should be replaced or cleaned.

IMPORTANT: Do not use cleaners containing methyl ethyl ketone.

Installation

1. Install the IAC to the IAC adapter using a new gasket. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
IAC bracket screws	19	168	–

2. Attach the IAC harness connector.
3. Install the engine cover.

Notes:

Fuel System

Section 5C - Fuel Injection Disassembly and Repair

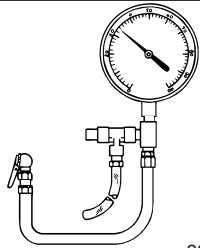
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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Threads of throttle body mounting studs	92-809821

Special Tools

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.
Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS).

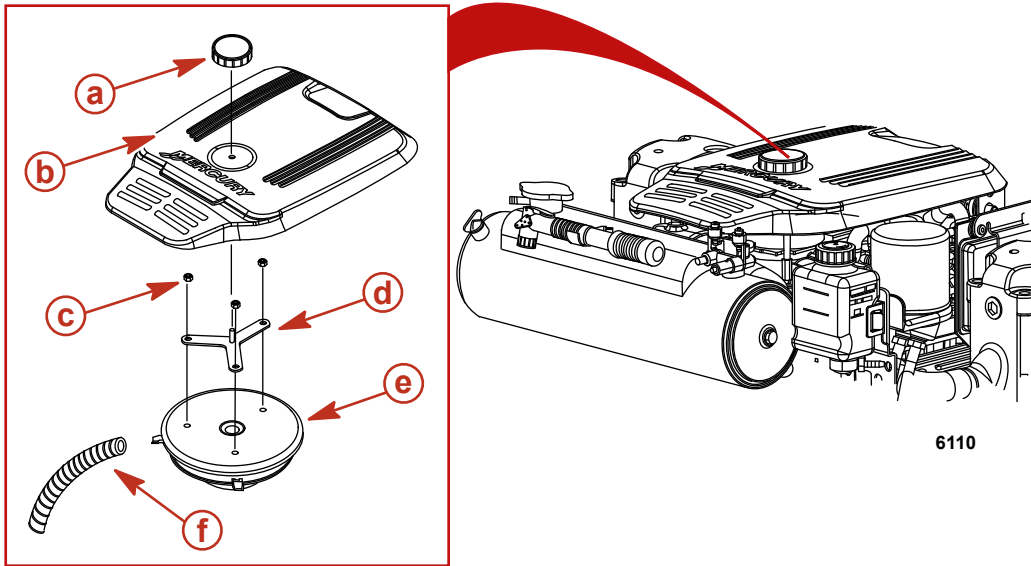
Disassembly

Flame Arrestor

Flame Arrestor Removal

1. Remove the retaining nut.
2. Remove the engine cover, if equipped.
3. Remove the flame arrestor retainer bracket.
4. Remove the breather hose.

- Remove the flame arrestor from the throttle body.



- a** - Engine cover knob
- b** - Engine cover
- c** - Flame arrestor nuts
- d** - Cover mount bracket
- e** - Flame arrestor
- f** - Crankcase ventilation hose

Flame Arrestor Cleaning and Inspection

Clean the flame arrestor in steam or water.

Dry the flame arrestor with compressed air.

Flame Arrestor Installation

- Install the flame arrestor on the throttle body.
- Install the breather hose.
- Install the flame arrestor retainer bracket.
- Install the engine cover.
- Install and tighten the retaining nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Flame arrestor retaining nut	12	106	–

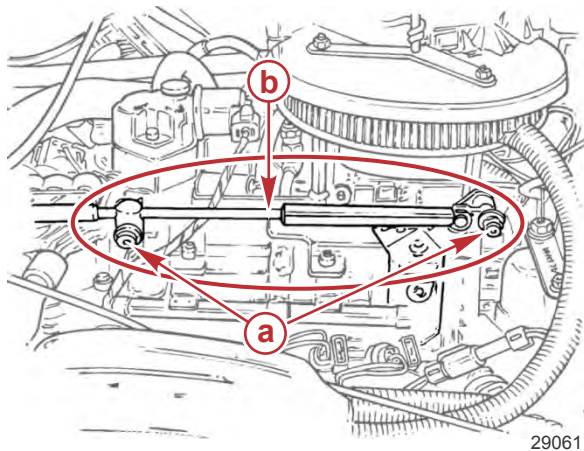
Throttle Body

Throttle Body Removal

- Remove the engine cover and the flame arrestor.

Fuel Injection Disassembly and Repair

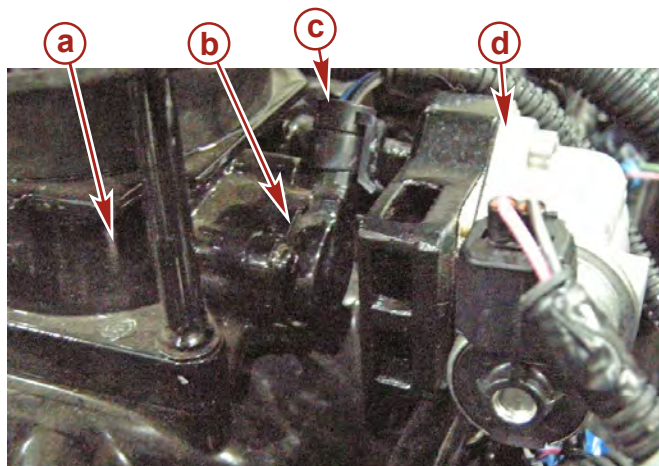
2. Disconnect the throttle linkage from the throttle body.



- a - Nuts
- b - Throttle cable

29061

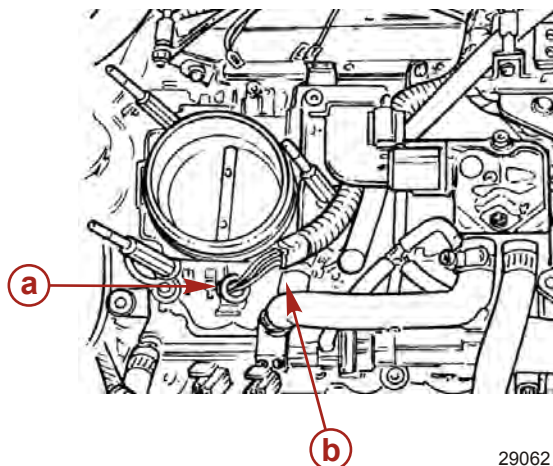
3. Disconnect the harness connectors from the throttle position sensor (TPS) and the idle air control (IAC) valve.



14 pin model

- a - Throttle body
- b - TPS
- c - TPS harness connector
- d - IAC

42540

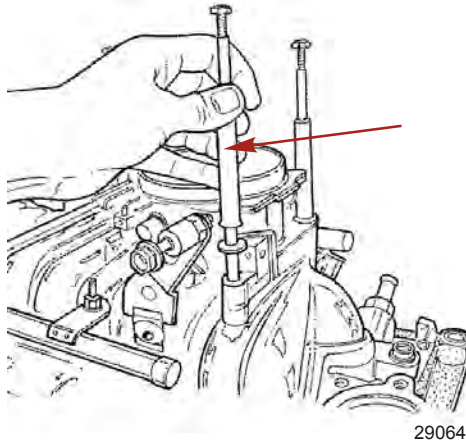


10 pin model

- a - TPS
- b - IAC hose

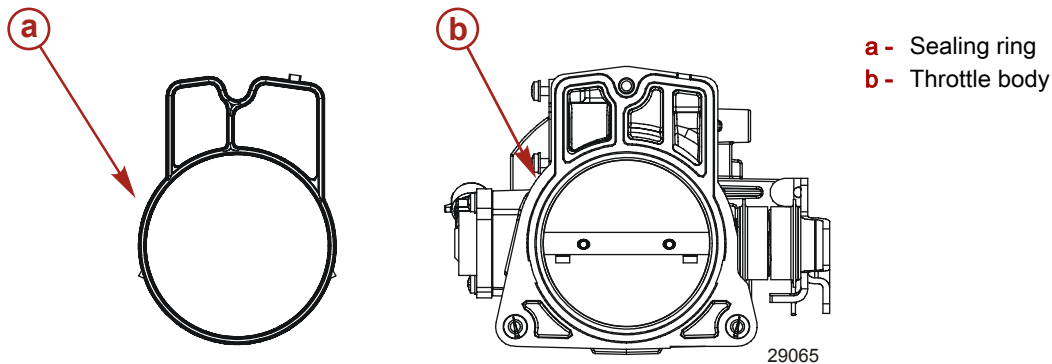
29062

4. Remove the throttle body attaching studs.



Removing studs

5. Remove the throttle body.
6. Remove and discard the throttle body sealing ring.



IMPORTANT: Insert a clean shop towel into the opening of the intake manifold to prevent foreign material from entering the engine.

Throttle Body Cleaning and Inspection

IMPORTANT: Do not use cleaners containing methyl ethyl ketone.

IMPORTANT: Do not contaminate the throttle position sensor (TPS) with cleaner or solvent.

IMPORTANT: Do not damage the adapter or throttle body when removing gasket material.

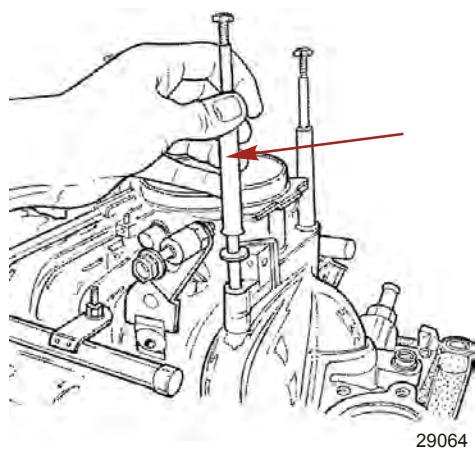
1. Carefully remove the gasket material from the intake manifold adapter and throttle body.
2. Remove the TPS.
3. Remove the IAC muffler.
4. Clean or replace the IAC muffler if grey or black. The muffler should be white. Refer to **Section 5B - MPI Fuel Delivery Systems**.
5. Thoroughly clean all parts of the throttle body. Ensure that all passages are free of debris and burrs.
6. Inspect the gasket mating surfaces for damage that could affect sealing.
7. Inspect the throttle body casting for cracks.
8. Inspect the throttle plates, linkage, return springs, and other components for damage, wear, and foreign material.

Throttle Body Installation

1. Install any components that were removed during the inspection and cleaning process.
2. Install a new throttle body sealing ring into the groove in the bottom throttle body plate.
3. Align the dowels and install the throttle body onto the upper intake manifold.
4. If reusing the fasteners, apply Loctite 242 Threadlocker to the threads of the throttle body mounting studs.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Threads of throttle body mounting studs	92-809821

5. Install and tighten the throttle body mounting studs to the specified torque.



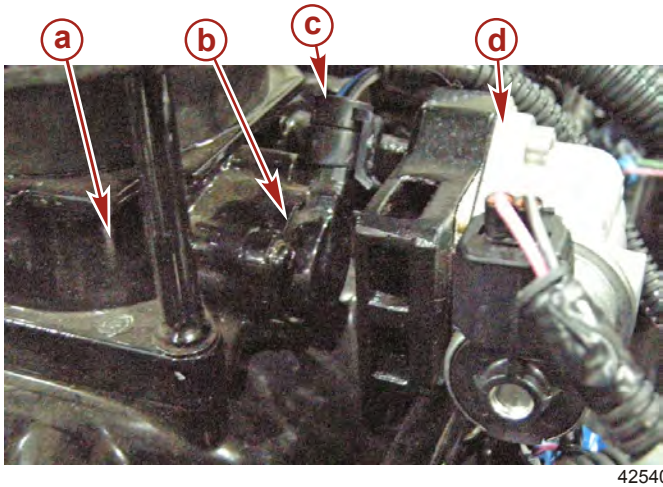
Throttle body mounting studs

Description	Nm	lb-in.	lb-ft
Throttle body mounting studs	9	80	–

6. Install the IAC muffler.
7. Install the throttle cable bracket. Tighten the nuts to the specified torque.

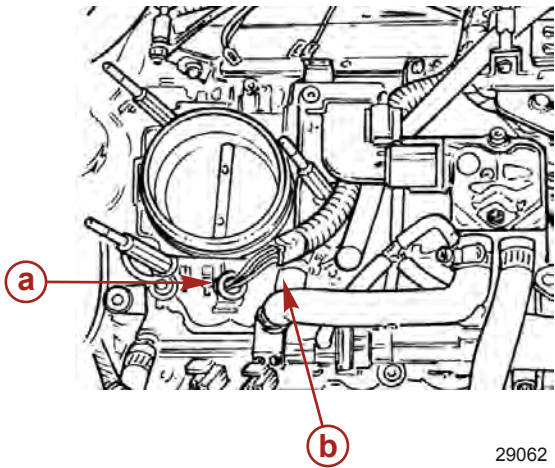
Description	Nm	lb-in.	lb-ft
Throttle cable bracket nuts	19	168	–

8. Connect the harness connector to the TPS and attach the IAC hose to the throttle body IAC plug.



14 pin model

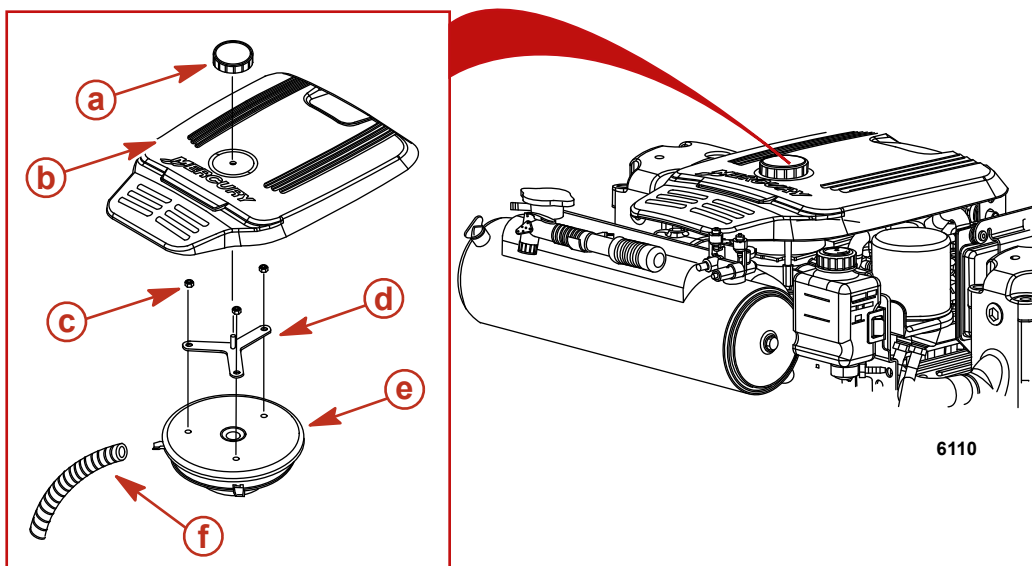
- a - Throttle body
b - TPS
c - TPS harness connector
d - IAC



10 pin model

- a - TPS
b - IAC hose

9. Install the flame arrestor. Tighten the nut to the specified torque.



- a** - Engine cover knob
- b** - Engine cover
- c** - Flame arrestor nuts
- d** - Cover mount bracket
- e** - Flame arrestor
- f** - Crankcase ventilation hose

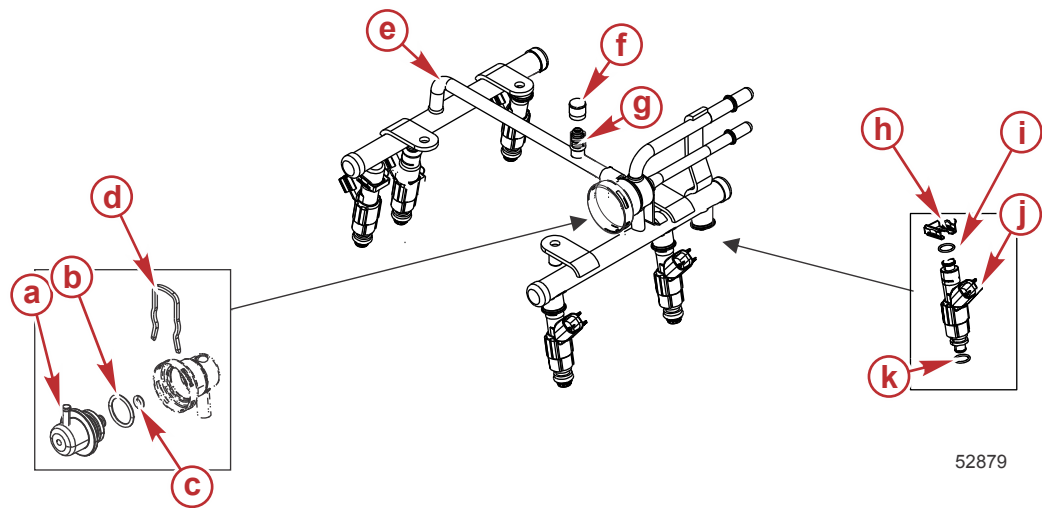
Description	Nm	lb-in.	lb-ft
Flame arrestor retaining bracket nut	12	106	–

10. Install the engine cover.

Fuel Rail

Fuel Rail and Fuel Injector Components

Removal



- a - Fuel damper
- b - O-ring
- c - O-ring
- d - Clip
- e - Fuel rail
- f - Dust cap
- g - Fuel pressure service valve
- h - Retainer
- i - O-ring
- j - Fuel injector (6)
- k - O-ring

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

- 1. Disconnect the negative (–) battery lead.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

- 2. Use a fuel pressure gauge to relieve pressure at the Schrader valve on the fuel rail. Drain the fuel into a suitable container and dispose of the fuel in a safe manner.

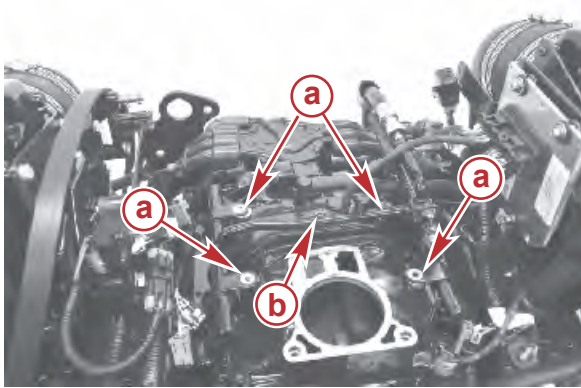
Fuel Pressure Gauge Kit	91-881833A03
Digital Pressure Meter	91-892651A01

- 3. Remove the fuel feed line from the fuel rail.

Description	SPX Part Number
Fuel line disconnect tool	J-44581

- 4. Use compressed air to remove dirt and debris from the fuel rail and injector area before removing the rail and injectors.

5. Remove the relay bracket with relays.
6. Disconnect the injector connectors.
7. Remove the vacuum line from the fuel regulator.
8. Remove the breather tube from the manifold.
9. Remove the throttle body. Refer to **Throttle Body Removal**.



- a** - Screws retaining fuel rail
b - Breather tube

52931

10. Remove the four screws retaining the fuel rail to the manifold.
IMPORTANT: Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
11. Carefully raise the fuel rails. Lift evenly on both sides of the fuel rail until all injectors are removed from their bores.

Installation

1. Inspect the injector and fuel regulator O-rings for damage. Replace if necessary.
NOTE: Lubricate the fuel injector O-ring seals with clean engine oil.
2. Install the injectors into the fuel rails.
3. Install the fuel rail onto the intake manifold. Ensure that the fuel rail and injectors are seated evenly so that the O-rings are not damaged.
4. Install the four screws retaining the fuel rail to the manifold.

Description	Nm	lb-in.	lb-ft
Fuel rail retaining screws	12	106	–

5. Install the throttle body with a new gasket. Refer to **Throttle Body Installation**.
6. Connect the vacuum line to the fuel regulator.
7. Connect the breather tube to the manifold.
8. Connect the fuel feed line to the fuel rail.
9. Connect the injector connectors.
10. Install the relay bracket with relays.
11. Install the flame arrestor and engine cover. Refer to **Flame Arrestor Installation**.
12. Connect the battery.
13. Pressurize the fuel system and inspect for leaks.

Notes:

Fuel System

Section 5D - Gen II Cool Fuel System

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Precautions

WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

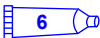
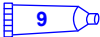
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

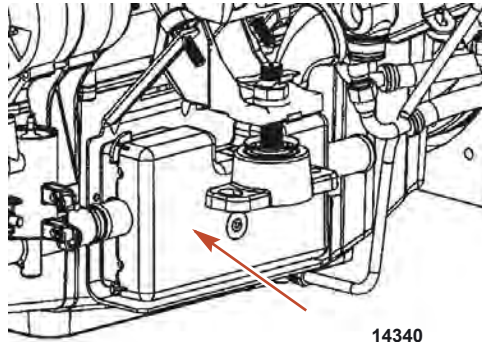
- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 6	Dielectric Grease	Retaining bracket	92-823506 1
 9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting	92-809822
 66	Loctite 242 Threadlocker	Fuel cooler mounting studs	92-809821

Cool Fuel System—Gen II

Mercury MerCruiser MPI models are equipped with a Cool Fuel system to resist vapor lock. In addition to the EFI fuel pumps and pressure regulator, the Cool Fuel system includes a cooler that cools the fuel continuously while the engine is running. The Cool Fuel module housing insulates Cool Fuel components from the heat in the engine compartment. The fuel pump assembly is mounted low on the engine to place it in the coolest location in the engine compartment. While servicing of the pumps is seldom required, as much clearance as possible should be provided in the front or side of the engine to allow access.

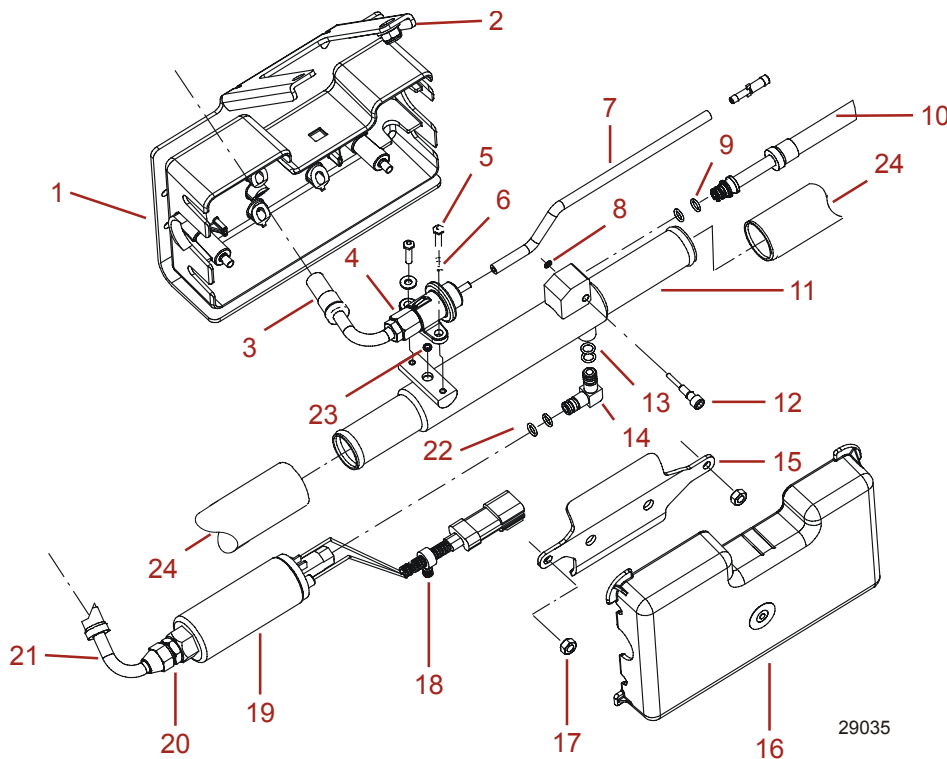


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Gen II fuel cooler

Exploded Views and Diagrams

Gen II Cool Fuel Module

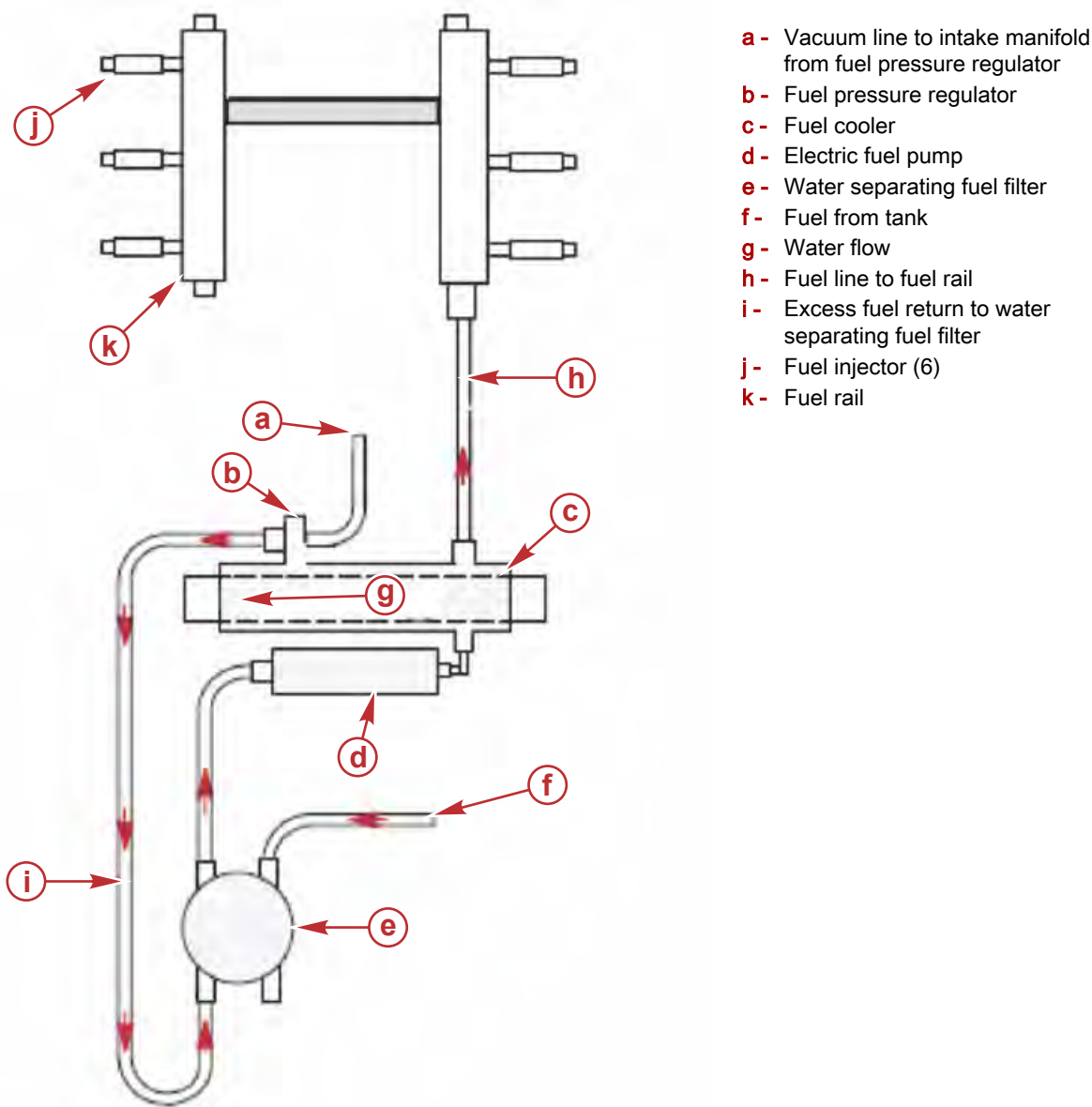


Gen II Cool Fuel system

- 1 - Cover base
- 2 - Bracket
- 3 - Return fuel line
- 4 - Fuel pressure regulator
- 5 - Screw (2)
- 6 - Washer (2)
- 7 - Vacuum hose
- 8 - Retaining ring
- 9 - O-ring (2)
- 10 - Pump-to-rail fuel line
- 11 - Fuel cooler
- 12 - Stepped bolt
- 13 - O-rings (2)
- 14 - Elbow fitting
- 15 - Bracket
- 16 - Cover
- 17 - Nut (2)
- 18 - Fuel pump wiring harness
- 19 - Electric fuel pump
- 20 - Fuel inlet fitting
- 21 - Fuel inlet line
- 22 - O-rings (2)
- 23 - Filter
- 24 - Seawater hose (clamp not shown)

29035

MPI Fuel System Flow Diagram



52690

Boost Pump

Gen II Cool Fuel with Boost Pump Inlet Fitting

⚠ WARNING

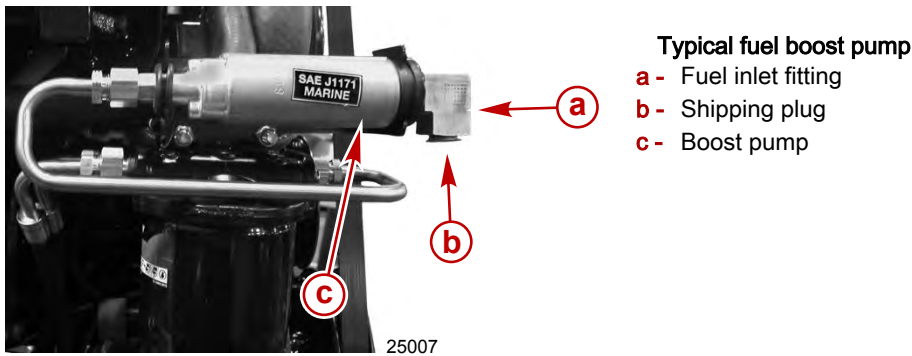
Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

- 1. Remove the shipping plug from the brass inlet fitting.
- 2. Apply Loctite 567 to the threads of a fuel inlet adapter or fitting.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting	92-809822

- 3. Install the adapter or fitting into the brass inlet fitting of the boost pump. To prevent cracking the casting or causing fuel leaks, turn the fuel inlet adapter or fitting in by hand until finger-tight. Tighten the fitting an additional 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.

IMPORTANT: Hold the brass fuel inlet fitting with a suitable wrench while tightening the fuel inlet adapter fittings.



Description	Procedure
Fuel inlet adapter or fitting	Finger-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.

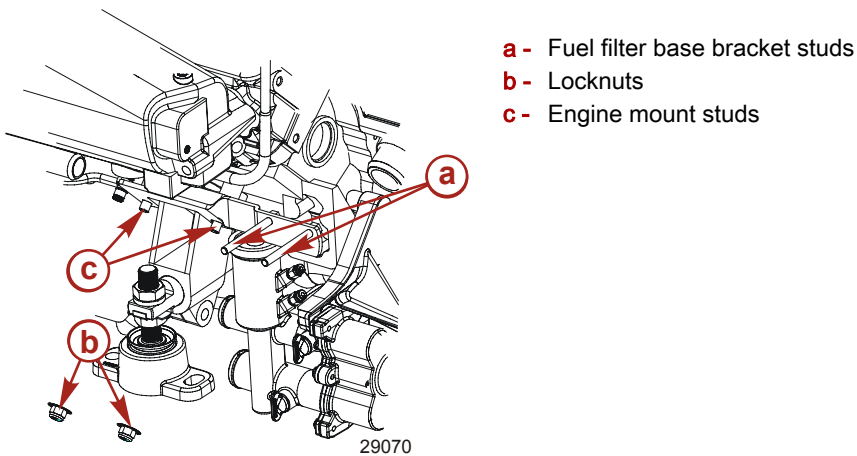
Boost Pump Removal

NOTE: Alpha models do not use a boost pump.

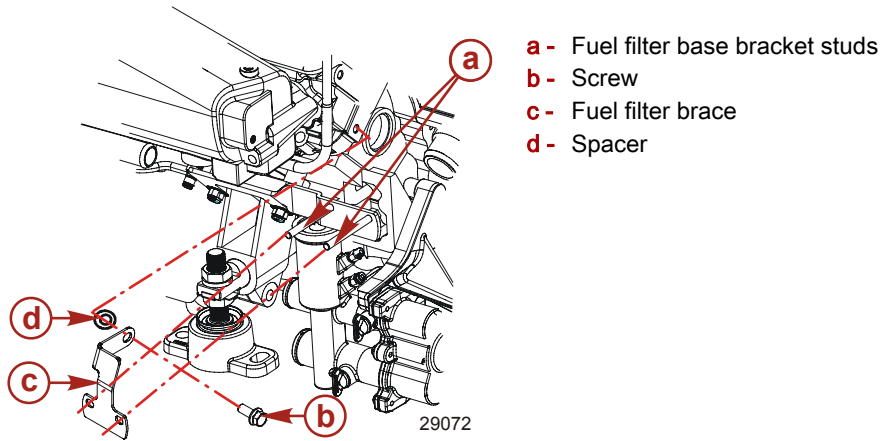
1. Disconnect both battery cables from the battery.
IMPORTANT: Cap the ends of all open fuel lines and connections to control fuel leaks and prevent fuel system contamination.
2. Disconnect and plug the fuel line from the fuel inlet fitting.
3. Remove the fasteners.
4. Remove the fuel pump.
5. Remove the water separating fuel filter.
6. Remove the insulator plate and fuel filter bracket.

Boost Pump Installation

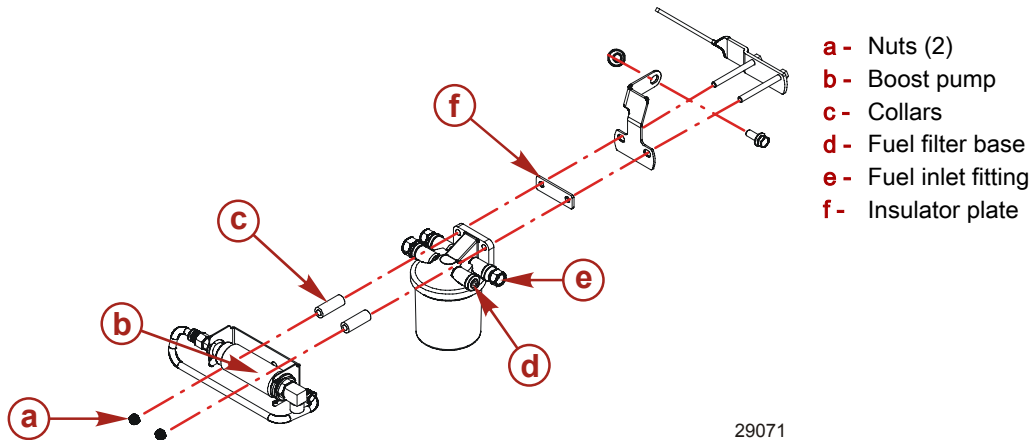
1. Place the fuel filter base bracket on the engine mount studs.
2. Install the two locknuts. Do not tighten at this time.



- Place the fuel filter brace onto the fuel filter base bracket studs.



- Fasten the brace to the cylinder head with the screw and spacer, installing the spacer between the brace and the cylinder head. Do not tighten at this time.
IMPORTANT: Ensure that no wiring or tubing is pinched between the brace and the cylinder head.
- Install the insulator plate and the fuel filter base on the bracket studs.
- Install one collar on each of the bracket studs.
- Install the boost pump assembly on the bracket studs.
- Install the two locknuts. Do not tighten at this time.
- Connect the boost pump fuel line to the fuel base inlet fitting. Do not tighten at this time.



- Tighten the two locknuts securing the fuel filter base bracket to the engine mount studs to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel filter base bracket to engine mount stud locknut	52	–	38

- Tighten the screw securing the filter brace to the cylinder head to the specified torque.

Description	Nm	lb-in.	lb-ft
Filter brace to cylinder head screw	52	–	38

- Tighten the two locknuts securing the boost pump bracket to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel filter base to bracket locknut	27	–	20

- Tighten the boost pump fuel line fitting to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel line fitting	24	–	18

- Connect the electrical harness to the connector on the Cool Fuel module and the engine harness connector.

15. Route the harness assembly along the lower port side of the engine to the rear of the engine and along the lower starboard side of the engine.
16. Connect the harness assembly connector to the harness connector on the boost pump.
17. Install the water-separating fuel filter. Refer to the instructions included with the filter.
18. Reconnect both battery cables to the battery. Be certain to connect the negative (–) cable last.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

19. Supply cooling water to all seawater inlets.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

20. Start the engine and check for leaks.

Gen II Cool Fuel System

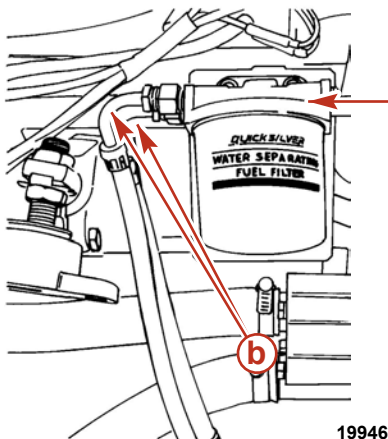
Removal

1. Disconnect the battery cables from the battery. Be certain to disconnect the negative (–) cable first.
IMPORTANT: Suitably plug the open ends of fuel line connections to prevent fuel leaks and entry of water or contaminants into the fuel lines while working.
2. Close the fuel shutoff valve, if equipped, and remove the fuel tank inlet line from the fuel boost pump. If the boat is not equipped with a fuel tank shutoff valve, remove the fuel tank inlet line at the fuel boost pump and plug the fuel line.

NOTICE

If the boat is at rest in the water with the engine off, an open seacock or water inlet hose could introduce water into the engine's cooling system or the boat. Keep the seacock or water inlet hose plugged until ready to start the engine. Attach a tag to the ignition switch or steering wheel to inform others of the water inlet connection.

3. Close the seacock, if equipped. If the boat is not equipped with a seacock, remove and plug the seawater inlet hose.
4. Drain the seawater system. Refer to **Section 1C**.
5. Disconnect the seawater hoses from the fuel cooler.
6. Disconnect the fuel lines from the water-separating fuel filter adapter.



- a -** Water-separating fuel filter adapter
b - Fuel lines

7. Remove the front cover.
8. Disconnect the fuel line from the fuel rail using the fuel line removal tool.

Description	Part Number
Fuel line removal tool	Obtain locally

9. Disconnect the fuel pump electrical connector.
10. Disconnect the vacuum hose connected to the pressure regulator in the Cool Fuel system.

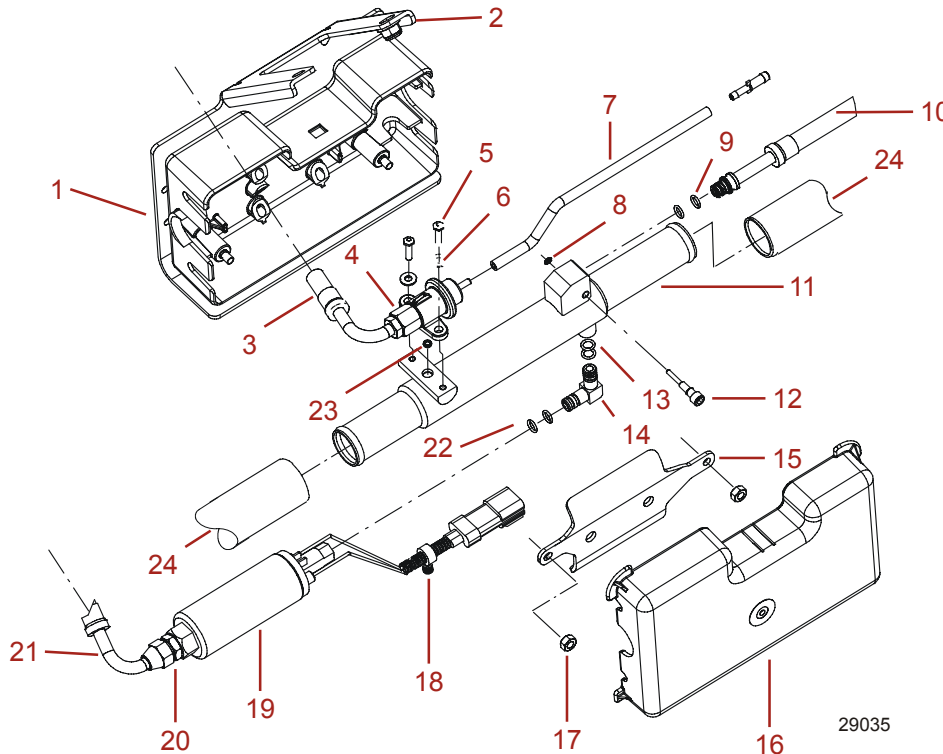
11. Remove the two upper engine mount bracket nuts securing the fuel cooler bracket to the engine.
12. Carefully remove the Cool Fuel system assembly.

Disassembly

NOTE: Retain all fasteners and hardware unless instructed otherwise.

1. Remove the Cool Fuel system cover.
2. Remove the two nuts from the Cool Fuel retaining bracket studs.
3. Remove the retaining bracket.
4. Disconnect the wiring harness from the cover base.
5. Remove the fuel cooler and the electric fuel pump assembly from the cover base.

IMPORTANT: To prevent loss of the stepped screw used to secure the fuel cooler to fuel rail fuel line, a retaining ring is provided. Loosen but do not remove the retaining ring or stepped screw.



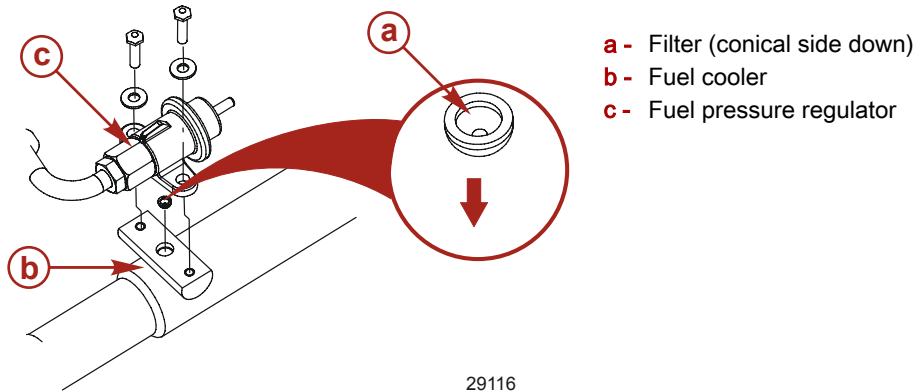
Cool Fuel system

- 1 - Cover base
- 2 - Bracket
- 3 - Return fuel line
- 4 - Fuel pressure regulator
- 5 - Screw (2)
- 6 - Washer (2)
- 7 - Vacuum hose
- 8 - Retaining ring
- 9 - O-ring (2)
- 10 - Pump-to-rail fuel line
- 11 - Fuel cooler
- 12 - Stepped screw
- 13 - O-rings (2)
- 14 - Elbow fitting
- 15 - Bracket
- 16 - Cover
- 17 - Nut (2)
- 18 - Fuel pump wiring harness
- 19 - Electric fuel pump
- 20 - Fuel inlet fitting
- 21 - Fuel inlet line
- 22 - O-rings (2)
- 23 - Filter
- 24 - Seawater hose (clamp not shown)

6. Loosen the stepped screw and remove the fuel line.
7. Hold the fuel line and fuel pump or fuel cooler fittings securely and remove the fuel lines.
8. Disconnect the elbow fitting and fuel pump from the fuel cooler assembly by pulling firmly.
9. Remove the elbow fitting from the fuel pump by pulling firmly on the fitting.
10. Hold the fuel line and regulator fittings securely and remove the fuel line.
11. Remove the fuel line fitting from the fuel pressure regulator.
12. Remove the two screws and washers retaining the fuel pressure regulator to the fuel cooler.
13. Remove the regulator.
14. Remove the filter from the fuel cooler.
15. Disconnect the vacuum hose from the regulator.

Assembly

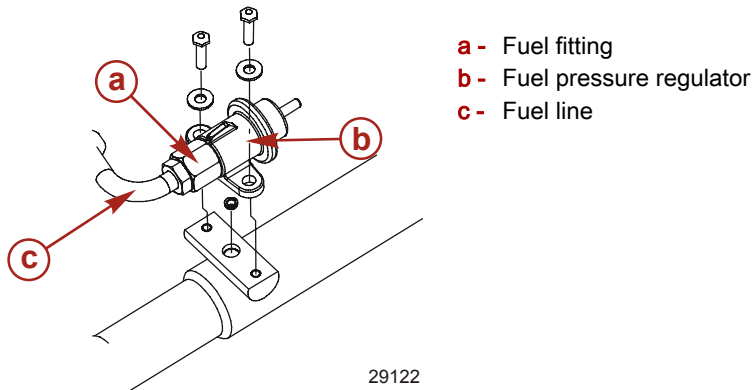
1. Install the filter (conical side down) into the orifice of the fuel cooler where the fuel pressure regulator mounts.



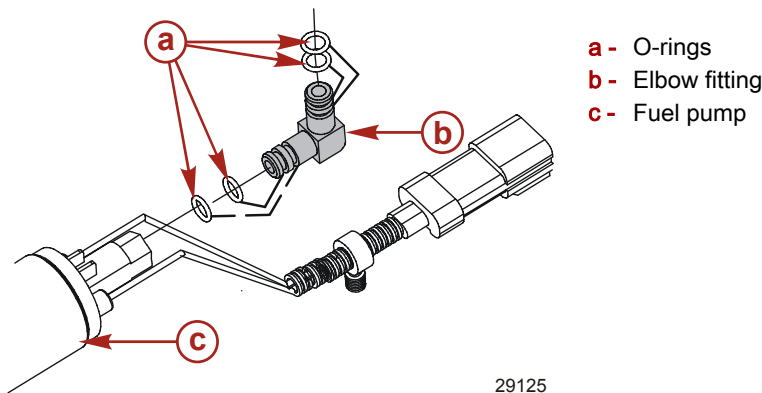
2. Install the regulator onto the cooler using the two screws with washers. Tighten to specification.

Description	Nm	lb-in.	lb-ft
Fuel pressure regulator screw	5.8	53	

3. Install the fitting into the regulator. Tighten securely.



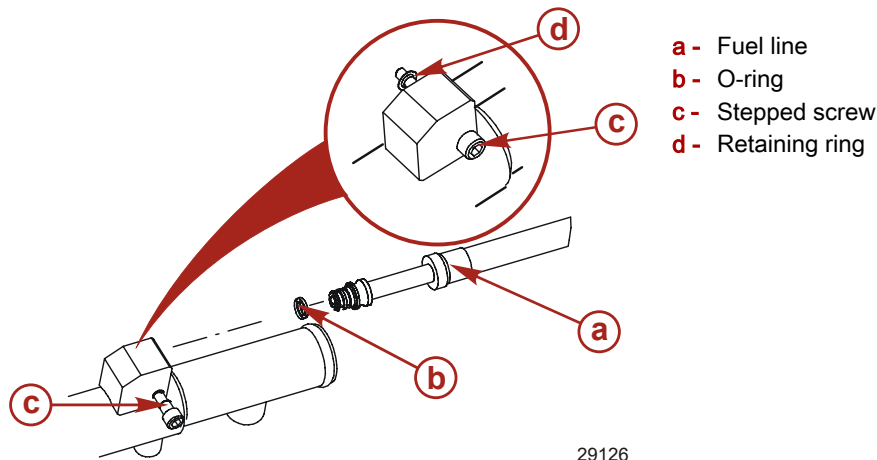
4. Connect the fuel line to the regulator. Tighten securely.
5. Install the vacuum hose onto the regulator.
6. Install the four O-rings onto the elbow fitting.



7. Lubricate the elbow fitting O-rings with a small amount of liquid dish soap (obtain locally).
8. Install the elbow fitting into the fuel pump.
9. Install the fuel pump and the elbow fitting into the cooler assembly.
10. Install the fitting with the O-ring into the end of the fuel pump.
11. Install the fuel line for the water separating fuel filter into the fuel pump fitting.
12. Install the seal onto the fuel cooler to fuel rail line.

IMPORTANT: To prevent loss of the stepped screw used to secure the cooler to fuel rail fuel line, a retaining ring is provided. Do not remove the retaining ring or stepped screw.

13. Confirm that the stepped screw that retains the fuel line is in place, but loose.
14. Lubricate the fuel line seal with a small amount of liquid dish soap (obtain locally).
15. Insert the fuel line into the cooler orifice. Tighten the stepped screw to specification.



Description	Nm	lb-in.	lb-ft
Stepped screw	9	81	

16. Position the complete fuel cooler assembly into the cover base.
17. Apply a thin, even coating of dielectric grease on all of the retaining bracket surface that contacts the cooler and the fuel pump.

Tube Ref No.	Description	Where Used	Part No.
 6	Dielectric Grease	Retaining bracket	92-823506 1

18. Install the retaining bracket over the cooler and fuel pump. Apply Loctite 242 to the threads of the fuel cooler mounting studs, and tighten the retaining bracket nuts to specification.

Description	Nm	lb-in.	lb-ft
Retaining bracket nuts	5.6	50	

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Fuel cooler mounting studs	92-809821

Installation

1. Place the Cool Fuel assembly onto the engine mount studs. Install the two nuts. Tighten them to specification.

Description	Nm	lb-in.	lb-ft
Engine mount stud nut	41		30

2. Connect the fuel lines to the fuel filter adapter. Tighten them to specification.

Description	Nm	lb-in.	lb-ft
Fuel fittings	24		19

3. Connect the fuel line to the fuel rail.
4. Connect the vacuum line to the intake manifold.
5. Attach the engine harness electrical connector to fuel pump harness connector.
6. Clip the fuel pump harness to the Cool Fuel base.
7. Connect the seawater hoses to the Cool Fuel system. Tighten the hose clamps securely.
8. Connect the seawater hoses.
9. Open the seacock, if equipped.

10. Connect the fuel inlet line from the fuel tank. Tighten the hose clamp securely. Open the fuel shut off valve, if equipped.
11. Connect the battery cables.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

12. Supply all seawater inlets with cooling water.
13. Start the engine and inspect for fuel and water leaks. Stop the engine immediately if any leaks exist. Make any necessary corrections.
14. Install the Cool Fuel system cover.

Notes:

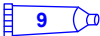
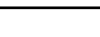
Cooling System

Section 6A - All Models

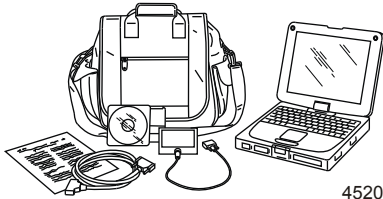
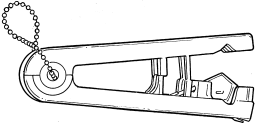
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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
 19	Perfect Seal	Water-circulating pump gasket and the threads of the attaching fasteners	92-34227Q02
 66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw threads	92-809821
 68	Loctite 609	Outer diameter of the front seal	Obtain Locally
 116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825
 139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Outer diameter of the bearings	92-858052K01
		Seawater pump shaft	
 142	Loctite 598 RTV Sealant	Wear plate on the seawater pump housing cover or the actuator housing	Obtain Locally

Special Tools

Computer Diagnostic System (CDS)	Bosch Automotive Service Solutions
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: www.mercurymarinecds.spx.com/contact.aspx or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222
Power Steering Pump Pulley Remover	SPX J-21239
 25952	Removes the pulley on the DHB power steering pumps and water pumps with smaller shafts.
Pulley Pusher Installer	91-93656A1
 10047	Installs the pulley onto the power steering pump.
Air Line Cutter	91-883502
 24887	Cuts water drain system air lines without collapsing them.

Specifications

Flow Specifications

Alpha Sterndrive Models

Model	Cooling	RPM	Minimum flow	Minimum pressure
All 4.3L models	Seawater cooling	4000	50 L/min (13 gal/min)	35 kPa (5 psi)
All 4.3L models	Closed cooling	4000	106 L/min (28 gal/min)	138 kPa (20 psi)

Bravo Sterndrive Models

Model	Cooling	RPM	Minimum flow	Minimum pressure
All 4.3L models	Seawater cooling	4000	50 L/min (13 gal/min)	69 kPa (10 psi)
All 4.3L models	Closed cooling	4000	106 L/min (28 gal/min)	138 kPa (20 psi)

Seawater Inlet Specifications

Seawater Inlet Specifications	
Seawater inlet hose	32 mm (1-1/4 in.) I.D. (wire-reinforced)
Seawater pickup	Low restriction with 32 mm (1-1/4 in.) connections
Seacock (ABYC requirement)	
Seawater strainer (optional)	

General Information

A Mercury MerCruiser engine has either a seawater-cooling system or a closed-cooling system. On engines with seawater cooling, the engine is cooled entirely by the water in which the boat is being operated. Closed-cooling systems use two cooling circuits, one of which mimics the seawater-cooling system. The second circuit uses a mixture of fresh water and coolant/antifreeze. Both types of systems are designed to maintain the engine operating temperature at approximately 71° C (160° F) for optimum performance, fuel economy, and durability.

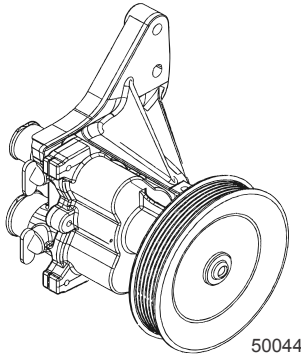
NOTE: Seawater cooling is sometimes referred to as raw-water cooling or standard cooling. Closed cooling is also known as fresh-water cooling.

The cooling system must receive a sufficient amount of seawater under all operating conditions to operate properly. The design and installation of the seawater supply system is the boat manufacturer's responsibility.

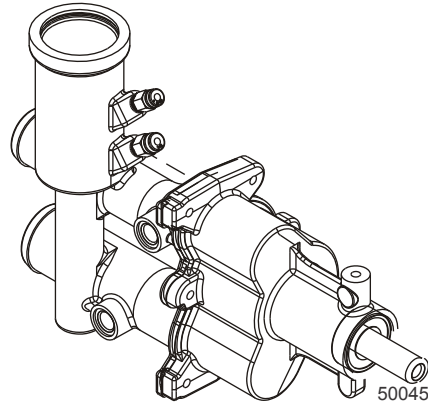
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Seawater Pump Identification



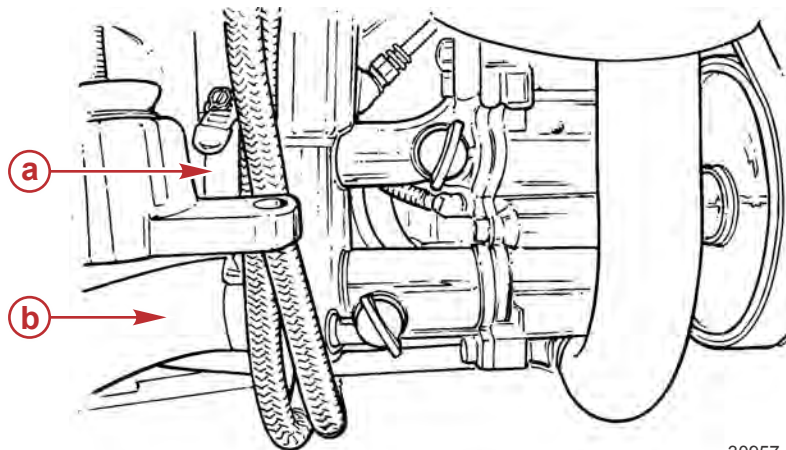
Brass seawater pump without air-actuated drain valve



Brass seawater pump with air-actuated drain valve

Seawater Inlet Hose

- Use a 32 mm (1-1/4 in.) I.D. wire-reinforced hose that is capable of supporting 34 kPa (10 in. Hg) of vacuum to prevent the seawater inlet hose from collapsing from the seawater pump suction.
- The hose should be oil and seawater resistant.
- Use the shortest hose length possible, with minimal bends to maximize flow.
- All connections must be secured with hose clamps.
- Fasten the hoses to maintain proper routing and to prevent chafing or contact with other moving parts.



- a** - Seawater inlet hose
- b** - Seawater outlet hose to cooler

30957

Seawater Pump Output Test

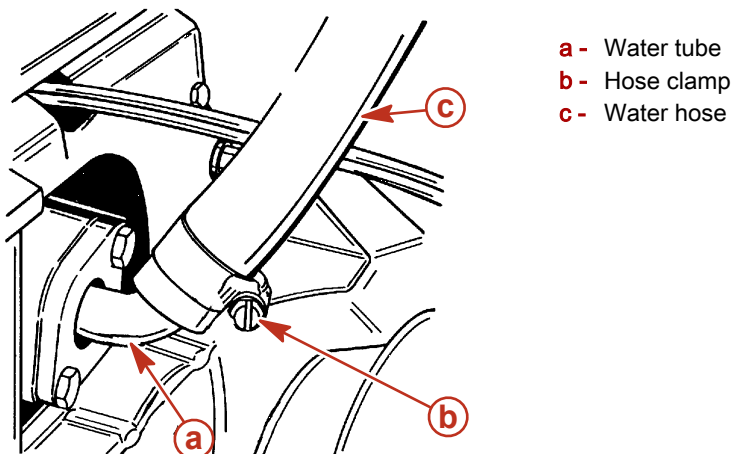
IMPORTANT: Note the following:

- The boat must be in the water for this test. This test cannot be performed with a flush-test device and water hose.
- Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.
- Perform this test accurately or problems may not be detected. An error in setting the engine RPM, timing the test, or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results:
 - Use a shop tachometer with an error rate of less than 5%. Do not use the boat tachometer as it may not have the necessary precision.
 - Use a stop watch to time the duration of the test to help ensure that accuracy is maintained.
 - Use a 9.5 L (10 US qt) or larger capacity container to measure the water output.

If the engine overheats, use this test to determine if a sufficient amount of water is being supplied to cool the engine:

1. **Models with engine-mounted seawater pumps:** Remove the water hose that is between the pump outlet and the engine, and replace it with another hose of the same diameter but approximately 1 m (3 ft) longer. The hose should have adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the pump outlet only. Do not clamp the hose at the engine cooler end.

2. **Models with a sterndrive-mounted-seawater pump (Alpha Models):** Remove the water inlet hose, which is between the gimbal housing water tube and the engine, and replace it with another hose of the same diameter but approximately 1 m (3 ft) longer. The hose should be of adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the gimbal housing water tube only. Do not clamp the hose at the engine end.



7802

3. Place a 9.5 L (10 US qt) or larger container near the unclamped end of the hose.
4. With the assistance of another person, using a shop tachometer, start the engine and adjust the speed to exactly 1000 RPM while holding the unclamped end of the hose on the connection on the engine. Remove the hose from the connection on the engine and direct the water flow into the container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return the engine to idle and stop the engine. Reconnect the hose to the engine.
5. Measure the quantity of water discharged into the container and compare with the specifications given in the following chart.

NOTE: Values listed are minimum discharge quantities. Typical values at 1000 RPM are approximately 1.4 times those listed.

Engine-Mounted Seawater Pump Output for a 15-Second Period	
Model	Minimum Quantity
Bravo model with seawater cooling	7.1 L (7.5 US qt)
Bravo model with closed cooling and an external water pickup	9.0 L (9.5 US qt)
All inboard and tow sport models	9.0 L (9.5 US qt)

Alpha Sterndrive Seawater Pump Output for a 15-Second Period	
Model	Minimum Quantity
Alpha models	4.7 L (5.0 US qt)

6. Repeat the test four times to confirm the results.

Collecting Water Pressure Data

Use the Mercury Computer Diagnostic System (CDS) to collect water pressure data on models equipped with a water pressure sensor.

Computer Diagnostic System (CDS)	Bosch Automotive Service Solutions
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IMPORTANT: On seawater-cooled Alpha sterndrive models, collect the water pressure data between the transom and the seawater inlet on the power-assisted steering fluid cooler.

IMPORTANT: On Alpha and Bravo sterndrive models with closed cooling, the water pressure data must be collected within 152 mm (6 in.) of the seawater pump inlet.

Specifications

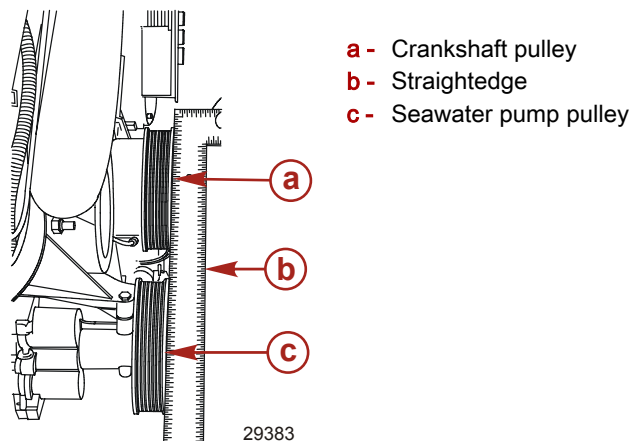
Refer to **Flow Specifications** at the beginning of this section.

CDS Connection to the Engine

For complete information about selecting the appropriate engine interface cables, connecting CDS to the engine, and system program operation, refer to the CDS software help system provided with the CDS program. CDS Help is a quick-access reference tool that provides comprehensive information on all of the various topics related to the Mercury Marine Computer Diagnostic System including proper CDS connection to the engine.

Seawater Pump Pulley Alignment

1. Place a straightedge across the seawater pump pulley and the crankshaft pulley.
2. The outer face of the seawater pump pulley may be slightly in front of or behind the outer face of the crankshaft pulley, but the two faces should be almost parallel.



3. The seawater pump pulley must be parallel within 1.5 mm (1/16 in.) of the straightedge. If it is not, replace the bracket.

Seawater Pump Bracket Replacement

1. Install the pump onto the new bracket. Tighten the seawater-pump-to-bracket fasteners to the specified torque.

Description	Nm	lb-in.	lb-ft
Seawater pump attachment fasteners	10	88	–

NOTE: If the original seawater pump bracket had washers between it and the engine cylinder block, discard them. The new bracket does not use washers between it and the cylinder block.

NOTE: A stiffening tab has been added to the new bracket. Consequently, the location of the mounting stud and bolt has to be changed.

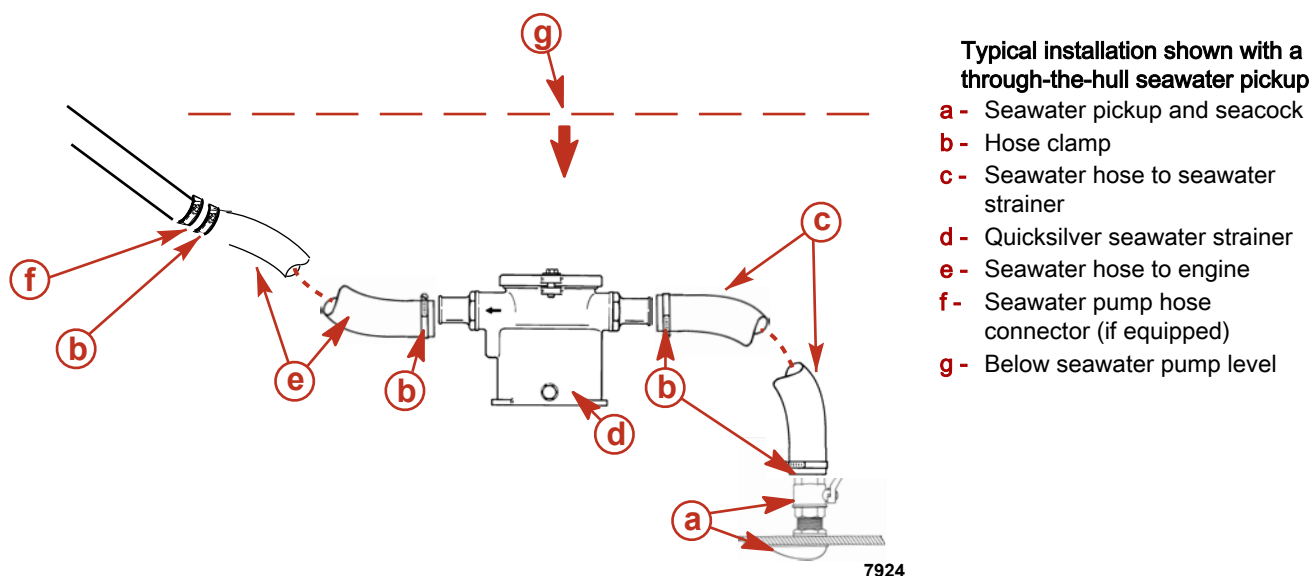
2. Move the stud from the lower cylinder block hole to the one that had the bolt in it.
3. Install the bracket onto the stud and then rotate it to install the original bolt through the lower bracket hole.
4. Tighten the seawater pump bracket fasteners to the specified torque.

Description	Nm	lb-in.	lb-ft
Seawater pump bracket fasteners	41	–	30

5. Install the serpentine belt and adjust it until there is a 13 mm (1/2 in.) deflection between the two upper pulleys.

Through-the-Hull Seawater Pickup System

IMPORTANT: Use a 32 mm (1-1/4 in.) I.D. wire-reinforced hose that is capable of supporting 34 kPa (10 in. Hg) vacuum when suction is created by the seawater pump impeller.



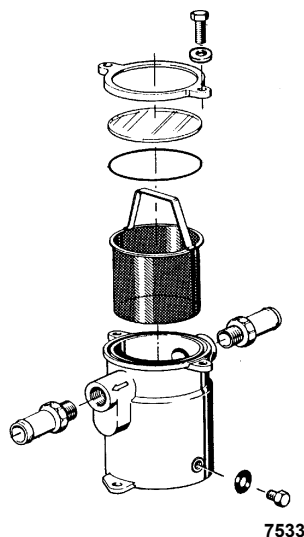
IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as the pickup may create turbulence and allow air to flow into the propeller slipstream. This will cause propeller ventilation and will adversely affect boat performance.

IMPORTANT: Make gradual bends in the seawater hoses to avoid kinks. Hoses must not come in contact with steering system components, engine coupler, or driveshaft.

- The seawater pickup must be large enough to permit sufficient seawater flow to engine seawater pump for adequate engine cooling.
- The seawater pickup also must supply a positive head while underway.
- The seawater pickup should be located as close to the seawater pump inlet as possible and in an area where an uninterrupted, solid stream of seawater will flow when the boat is underway.

Seawater Strainer

A seawater strainer is recommended if the boat is operated in an area with a high debris content. Use 32 mm (1-1/4 in.) I.D. wire-reinforced hoses on the inlet and outlet sides of the strainer fittings. The strainer must be sized to minimize restriction (refer to **Specifications**) and to provide a reasonable service interval. Locate the strainer in an area that is accessible for servicing. If the boat is not equipped with a seacock, the strainer should be located above the waterline to prevent seawater entry into the boat when servicing. The strainer must have a provision to allow draining in freezing temperatures.



Typical seawater strainer

Seawater Pickup

Either a through-transom or through-hull seawater pickup can be used. Select the pickup location to minimize the length of the 32 mm (1-1/4 in.) I.D. wire-reinforced seawater inlet hose, while providing an optimum location for seawater pickup. The location should be in an area that provides a solid, air-free flow of seawater under all operating conditions. Avoid areas with a disturbed seawater flow, such as those behind or in close proximity to the propeller. Locations that are too far forward or outboard should also be avoided as these are prone to aeration problems at high boat-trim angles and while turning.

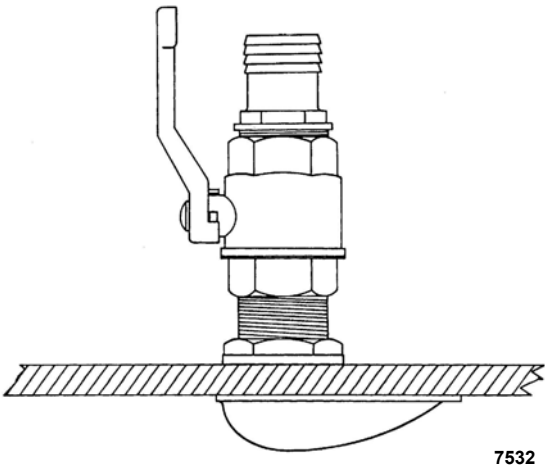
IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as the pickup may create turbulence and allow air to flow into the propeller slip-stream. This will cause propeller ventilation and will adversely affect boat performance.

Openings in seawater pickup should be a maximum of approximately 3 mm (1/8 in.) to prevent large debris from entering and clogging the cooling system.

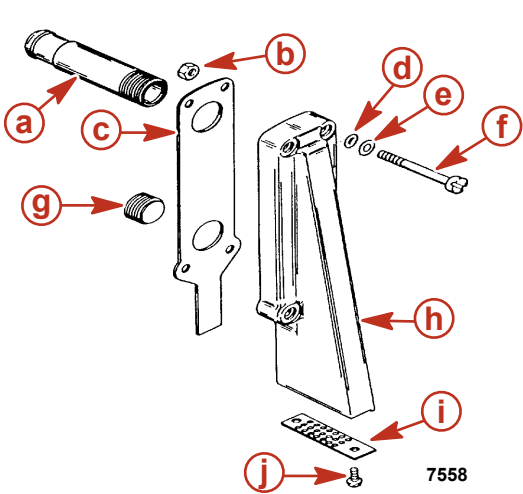
IMPORTANT: Use a seawater strainer if the seawater pickup openings exceed 3 mm (1/8 in.).

Some industry standards and regulations require that the pickup be connected into the boat's bonding system to minimize stray current corrosion. Refer to applicable standards and regulations for more details.

IMPORTANT: An external seawater pickup must have an integral seacock.



Seawater pickup with an integral seacock



Transom pickup

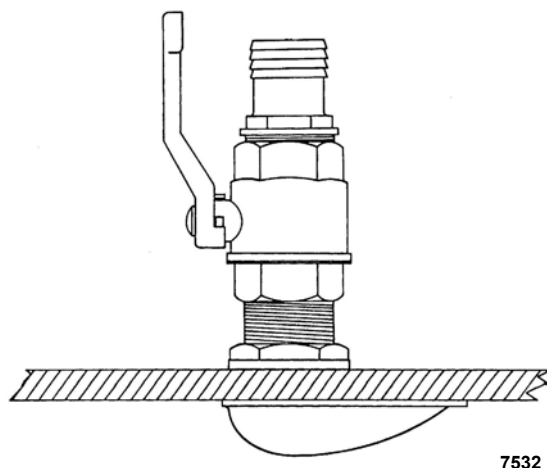
- a** - Hose fitting - apply Loctite 567 to the threads
- b** - Nut (4)
- c** - Gasket
- d** - O-ring (4)
- e** - Washer (4)
- f** - Screw (4)
- g** - Plastic plug - apply Loctite 567 to the threads
- h** - Pickup - apply RTV 587 to the sealing surfaces
- i** - Screen
- j** - Screw (2) - apply RTV 587 to the shaft

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
 116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825

Seacock

The American Boat and Yacht Council (ABYC) and other industry standards and regulations require the use of a seacock on certain types of applications to stop the entry of seawater in the event of a leak in the cooling system. Refer to applicable standards and regulations for specific requirements. The seacock also allows the seawater to be shut off when servicing the engine.

The seacock must provide minimum restriction to seawater flow (refer to **Specifications**). A ball valve or gate valve is recommended. The ball valve is most common and is typically equipped with a lever type handle that operates in a 90° arc. This design gives a clear indication of whether the valve is open or shut. Industry standards require that the seacock be rigidly attached to the hull at the seawater pickup. The seacock's location should be accessible for quick, easy operation.



Typical seacock

Seawater Strainer

Seawater Strainer Mounting Requirements

Use a properly sized strainer to maintain an adequate supply of water for cooling the engine.

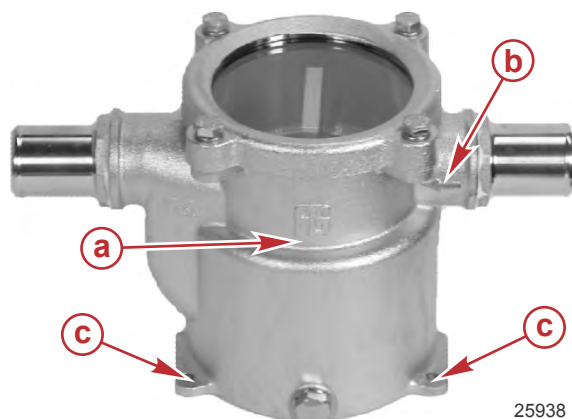
- Mount the seawater strainer in a location that will allow easy access for servicing, and maintenance.
- Mount the seawater strainer in a vibration free location.
- Do not mount the seawater strainer on the engine.
- If not equipped with a seacock, mount the seawater strainer above the seawater-line to prevent seawater entry into the boat when servicing.
- Use a 32 mm (1-1/4 in.) I.D. wire-reinforced hose.
- Do not allow hoses to contact hot or moving parts on the engine.

Seawater Strainer Installation

Refer to the manufacturer's instructions for detailed installation, operation, and maintenance.

IMPORTANT: Use the following guidelines when installing a Mercury seawater strainer.

1. Position the seawater strainer in an appropriate location, below the level of the seawater pump.
2. Ensure that the arrow that indicates the direction of seawater flow points toward the seawater pump.
3. Install the seawater strainer using flat washers and lag bolts.



- a - Seawater strainer
- b - Arrow indicating direction of water flow
- c - Mounting bolt hole location (bolts not shown)

Cleaning the Seawater Strainer, if Equipped

NOTICE

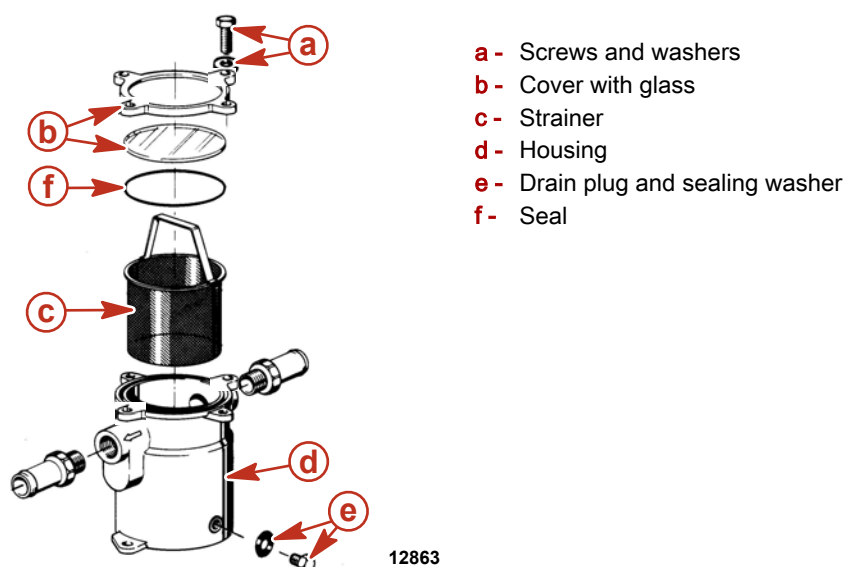
An open seawater strainer or seacock during some service or maintenance procedures can introduce water into the boat, causing damage or sinking the boat. Always close the water supply from the seawater pump, water inlet, or seacock when performing service or maintenance on the cooling system.

1. With the engine off, close the seacock, if equipped, or remove and plug the seawater inlet hose.
2. Remove the screws, washers, and cover.
3. Remove the strainer, drain plug, and sealing washer.
4. Clean all the debris from the strainer housing. Flush both the strainer and housing with clean water.
5. Check the cover gasket and replace when damaged or if it leaks.
6. Reinstall the strainer, drain plug, and sealing washer.

⚠ CAUTION

Seawater leaking from the seawater strainer could cause excess water in the bilge, damaging the engine or causing the boat to sink. Do not overtighten the cover screws, or the cover may warp and introduce seawater into the bilge.

7. Install the seal and cover using the screws and washers. Do not overtighten the cover screws.



8. Open the seacock, if equipped, or remove the plug and reconnect the seawater inlet hose.
9. Upon first starting the engine, check for leaks or air in the system that would indicate an external leak.

Water Heater Installation

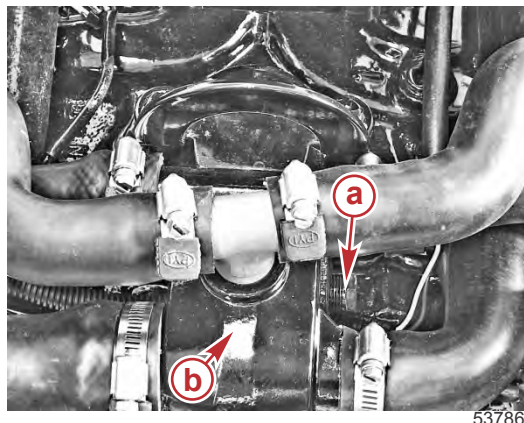
IMPORTANT: When connecting a cabin heater or water heater:

- The supply hose (from engine to heater) and return hose (from heater to engine) must not exceed 16 mm (5/8 in.) inside diameter (I.D.).
- Make heater connections only at the locations shown.
- Refer to the manufacturers' instructions for complete installation information and procedures.
- Do not reposition the engine temperature switch.

NOTICE

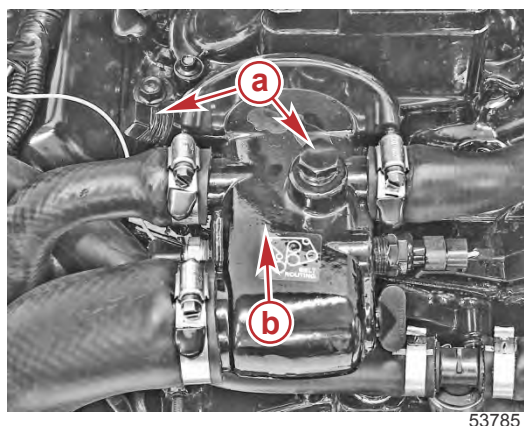
Blocking the coolant flow at the heater can cause reduced engine performance or overheating. Check for continuous coolant flow from the engine to the water circulating pump.

Supply Hose Connection—TKS Models



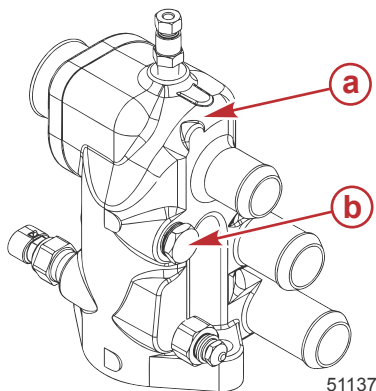
- a** - Location for hot water supply
- b** - Thermostat housing

Supply Hose Connection—MPI Models



- a** - Location for hot water supply
- b** - Thermostat housing

Models with Closed Cooling



- a** - Thermostat housing
- b** - Location for hot water supply

Return Hose Connection

IMPORTANT: A special fitting, 865526, may be used if the hex of the standard hose barb fitting contacts the water pump housing, not allowing the fitting to turn before the fitting is tight.

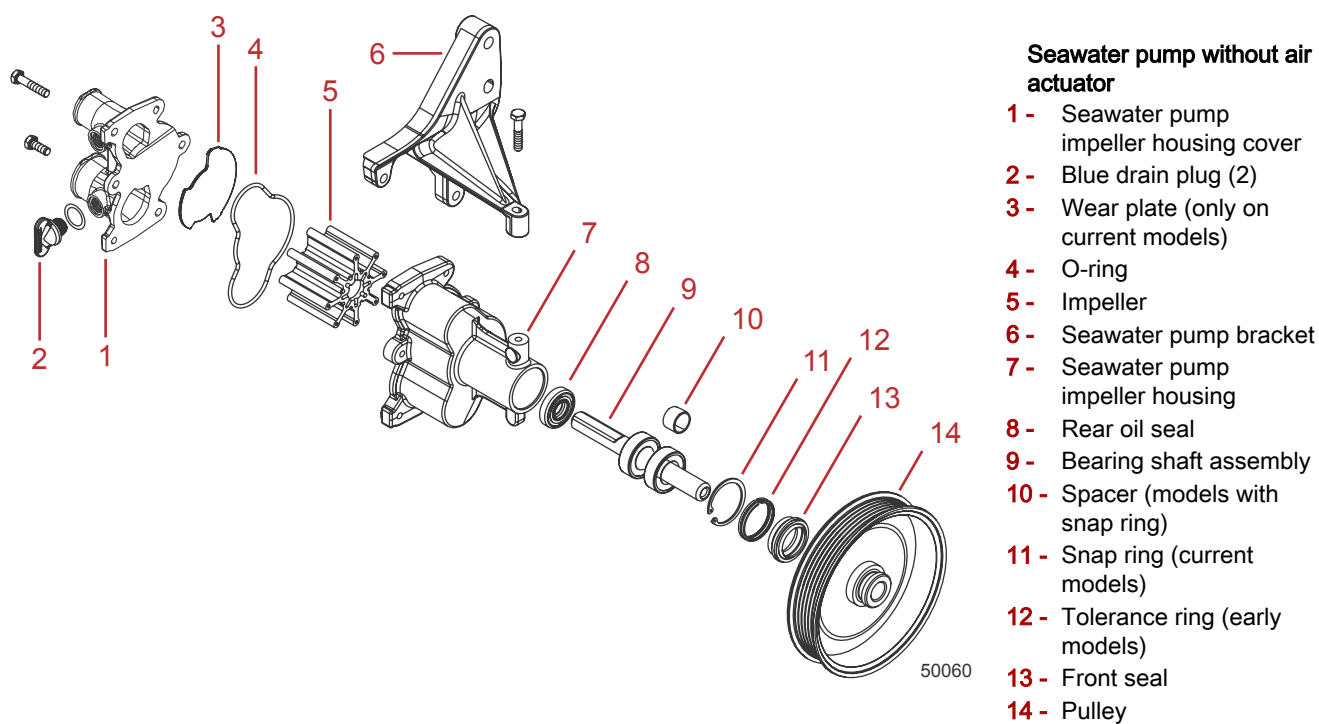


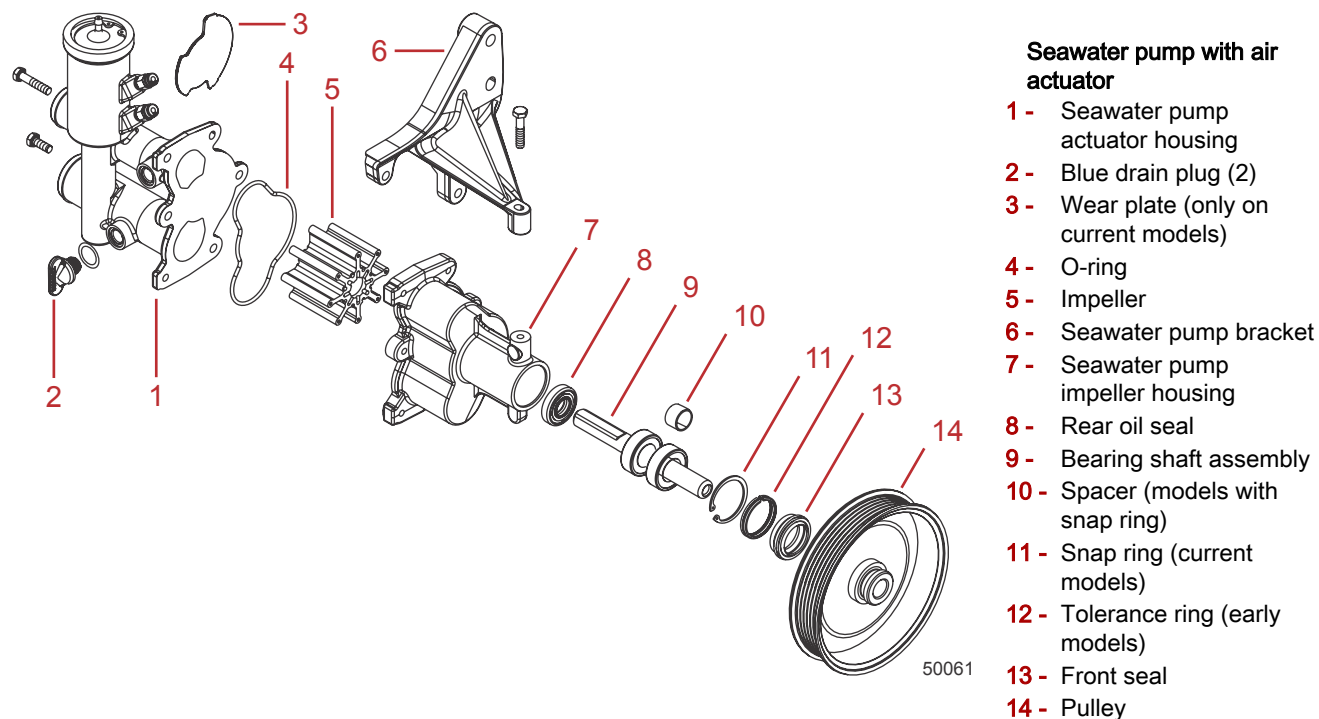
a - Standard fitting

b - Special fitting

Brass Seawater Pump

Seawater Pump Exploded View





Removal

1. Drain the seawater section of the cooling system.
2. Remove both of the hoses from the aft side of the seawater pump.
3. For models equipped with an air-actuated drain valve:
 - a. Disconnect the vent hose from the top of the drain valve.
 - b. Disconnect the air hoses from the drain valve, by pushing in and holding the plastic ring around the air hose, and pulling the air hose out of the fitting.

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

4. Remove the serpentine drive belt.
5. Remove the seawater pump and bracket assembly.

Disassembly

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

1. Remove the seawater pump mounting bracket.
2. Remove the seawater pump pulley using an appropriate puller.

Power Steering Pump Pulley Remover	SPX J-21239
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3. Remove the seawater pump impeller housing cover or the seawater pump actuator housing, if applicable.
4. Remove the O-ring.
5. Remove the impeller.
6. Remove the seal from the front of the seawater pump housing.
7. Remove the tolerance ring or snap ring (whichever is present).
8. Press the bearing shaft assembly out of the housing from the impeller side.
9. Remove the rear oil seal.

Cleaning and Inspection

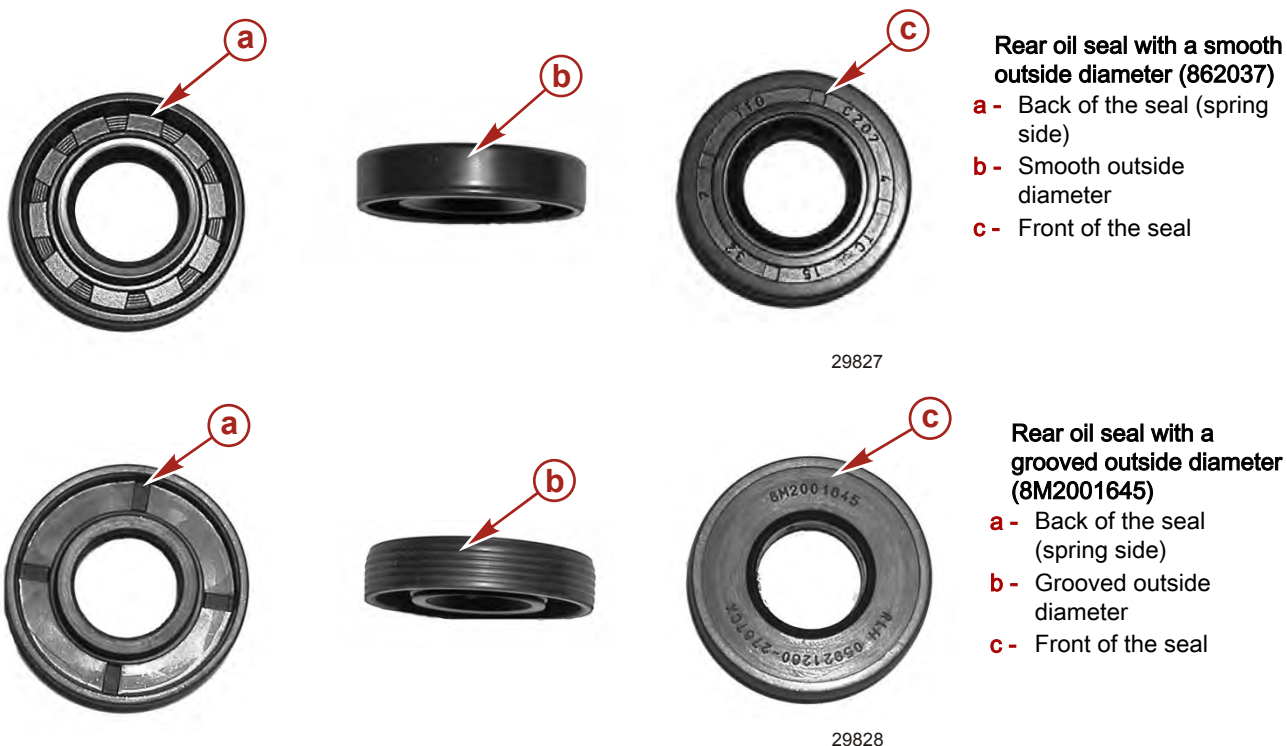
⚠ WARNING

Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

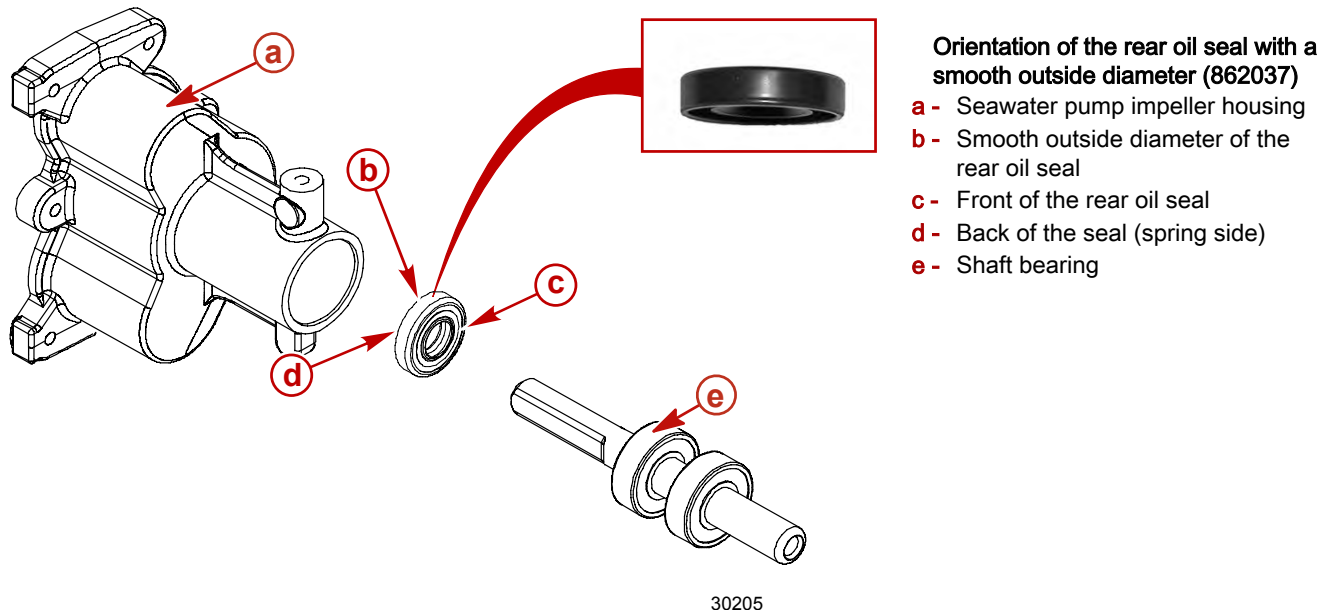
1. Clean the metal parts in solvent and dry with compressed air.
2. Clean the gasket material and sealant from the sealing surfaces.
3. Inspect the bearing housing. Examine the surfaces where the bearings contact the housing for evidence of the bearing outer races turning in the housing.
4. Inspect the seals in the bearing housing for signs of damage or leaks.
5. Rotate the bearing shaft in the bearing housing. Replace the bearing shaft assembly if the bearings feel rough or if either end of the shaft wobbles.
6. Inspect the impeller housing and impeller housing cover surfaces where the impeller rides. Replace the impeller housing if significant grooves exist.
7. If equipped with a wear plate, inspect the wear plate for grooves and replace as necessary.
8. If not equipped with a wear plate, inspect the face of the impeller housing cover for grooves. The face of a brass impeller housing cover can be resurfaced to remove grooves. Remove a maximum of 1.0 mm (0.040 in.) of material.
9. Inspect the pump impeller and replace it if any of the following conditions exist:
 - Wear on the ends and tips of the blades
 - Cracks in the area where the blades flex
 - Cracks in the impeller hub
 - Blade set (blades remain curved)
10. Inspect the pump pulley for bends or cracks.
11. Inspect the serpentine belt for excessive wear.

Assembly

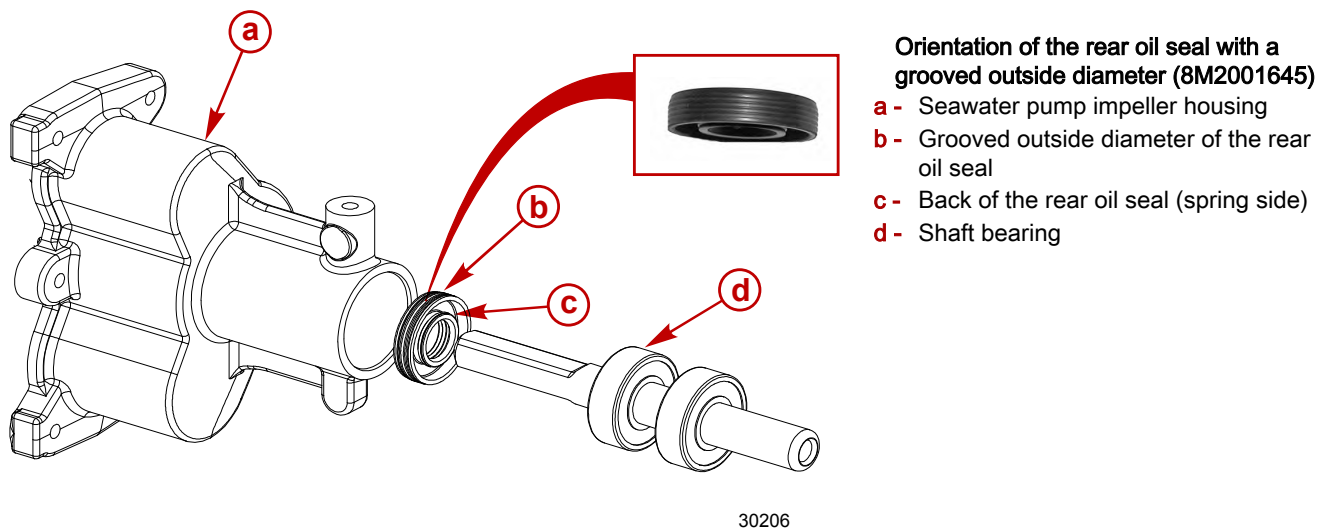
IMPORTANT: Rear oil seal 862037 is superseded by 8M2001645. However, the two seals are not installed in the same manner. Using the illustrations below, confirm the rear oil seal part number prior to assembling the seawater pump.



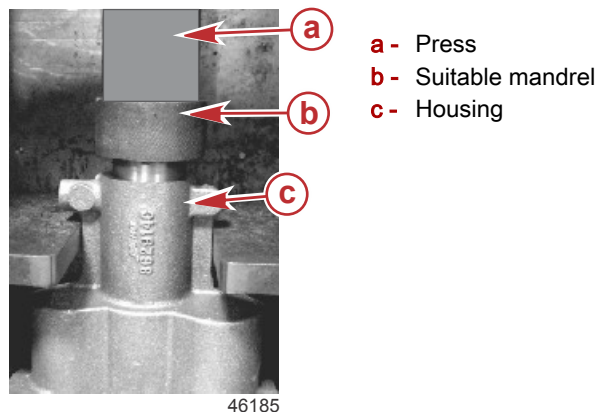
1. For the rear oil seal with a smooth outside diameter (862037), orient the back (spring side) of the seal toward the impeller housing.



2. For the rear oil seal with a grooved outside diameter (8M2001645), orient the front of the seal toward the impeller housing.



3. Using a suitable mandrel, press the seal to seat it in the housing.

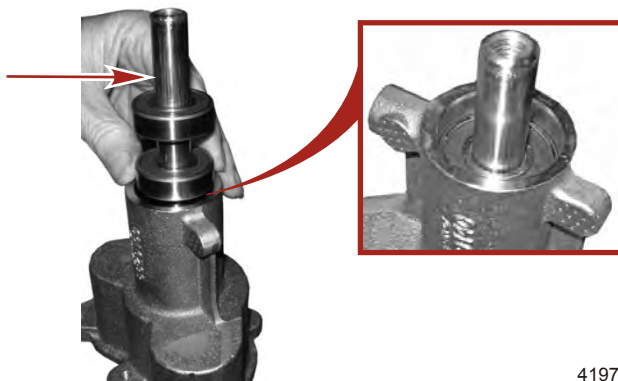


4. Lubricate the bearing shaft and the outer diameter of the bearings with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
 139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Outer diameter of the bearings	92-858052K01

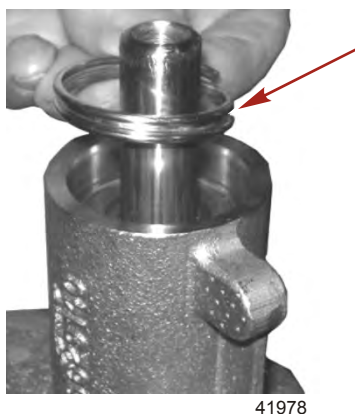
IMPORTANT: The bearing shaft assembly should slip easily into the bearing housing using only minimal force.

5. Install the bearing shaft assembly into the impeller housing. The end of the shaft with flat surfaces should extend into the impeller cavity. Clean any assembly lube or oil from the forward end of the impeller housing.



Bearing shaft assembly

6. Insert the tolerance ring (early models) or snap ring (current models) into the impeller housing.

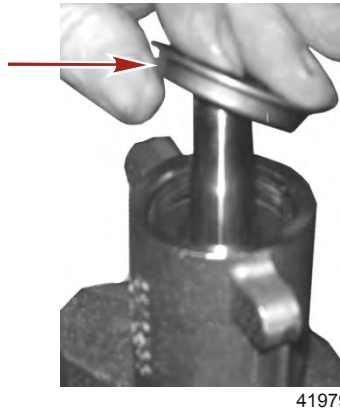


Tolerance ring (early models)

7. Apply Loctite 609 to the outer diameter of the front seal. Do not allow adhesive to contact the seal portion or the bearing shaft assembly.

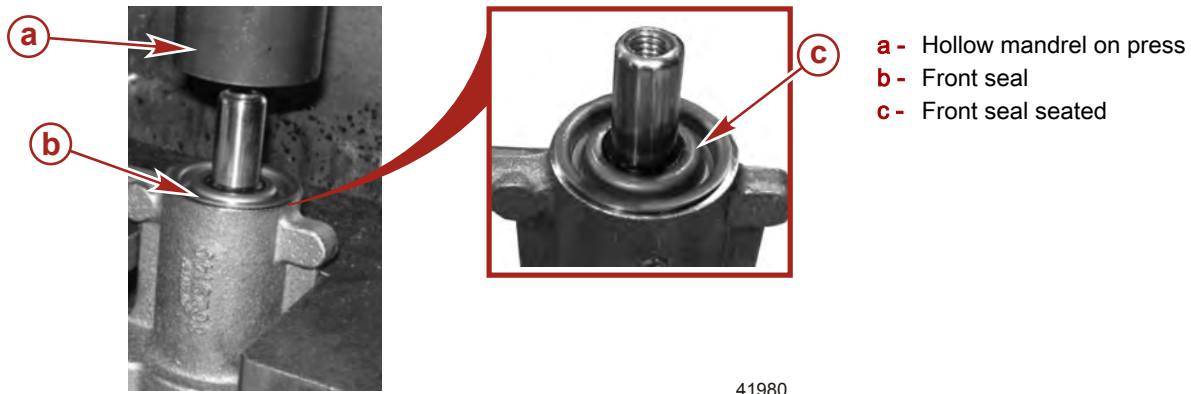
Tube Ref No.	Description	Where Used	Part No.
 68	Loctite 609	Outer diameter of the front seal	Obtain Locally

8. Install the front seal onto the bearing shaft assembly and slide it down until it contacts the end of the impeller housing.



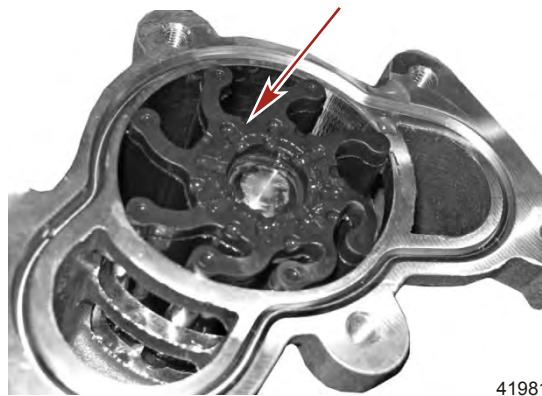
Front seal

9. Use a suitable mandrel that will press the front seal without contacting the bearing shaft. Press the front seal into place. Wipe away excess adhesive.



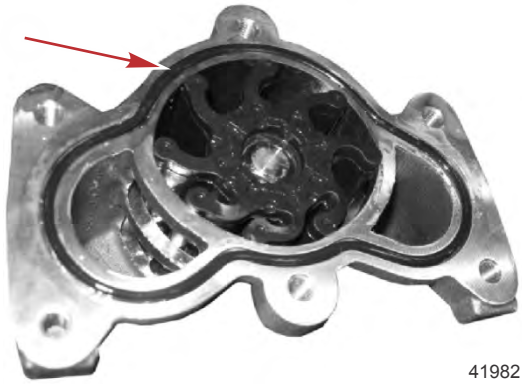
IMPORTANT: Only use the inner wear plate with the shorter impeller. This impeller is colored orange on alternate vanes. The plate and shorter impeller come as a set. Standard length impellers are also available.

10. Lubricate the impeller with soapy water. Align the flat surfaces of the impeller hub and bearing shaft, and install the impeller into the impeller cavity.



Impeller installed

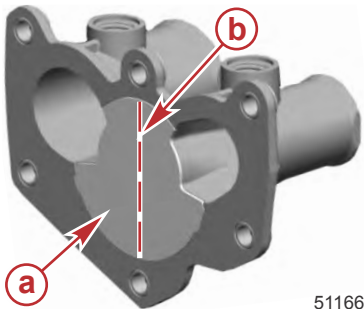
11. Install the O-ring into the groove in the impeller housing rear face.



O-ring installed in groove

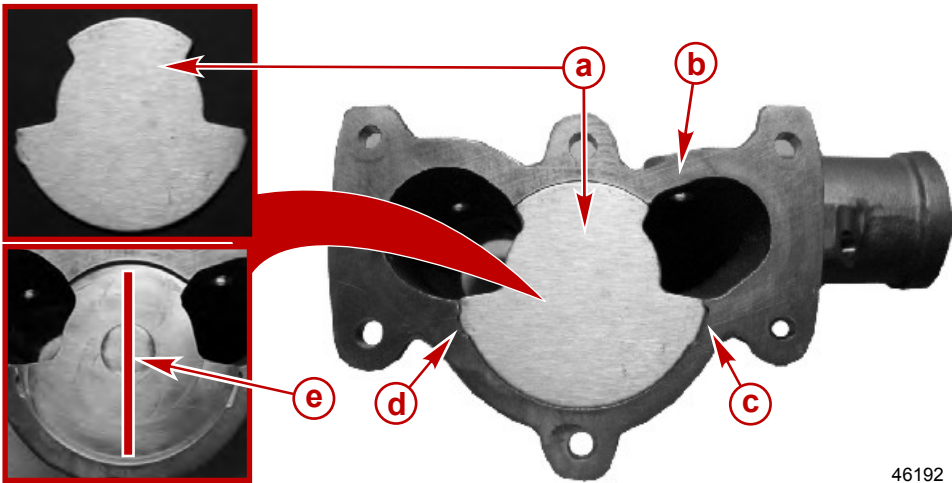
12. If the housing cover or actuator housing has a wear plate, and the plate is not already installed:

a. Apply a 3 mm (1/8 in.) bead of Loctite 598 to the housing cover.



Composite housing cover with wear plate

- a - Stainless steel wear plate
- b - Bead of adhesive (behind the wear plate)



Brass actuator housing with wear plate

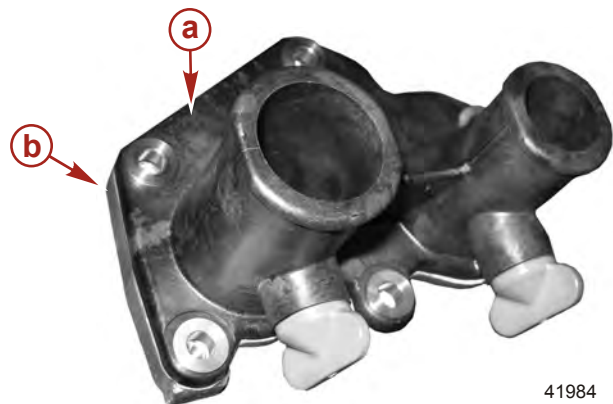
- a - Stainless steel wear plate
- b - Actuator housing
- c - Large tab
- d - Small tab
- e - Adhesive on the actuator housing

Tube Ref No.	Description	Where Used	Part No.
 142	Loctite 598 RTV Sealant	Wear plate on the seawater pump housing cover or the actuator housing	Obtain Locally

IMPORTANT: Position the wear plate on the housing cover or actuator housing and attach the assembly to the impeller housing within five minutes of applying the Loctite 598.

b. Install the stainless steel wear plate.

13. Align and install the impeller housing cover or the seawater pump actuator housing (if equipped) onto the impeller housing assembly.

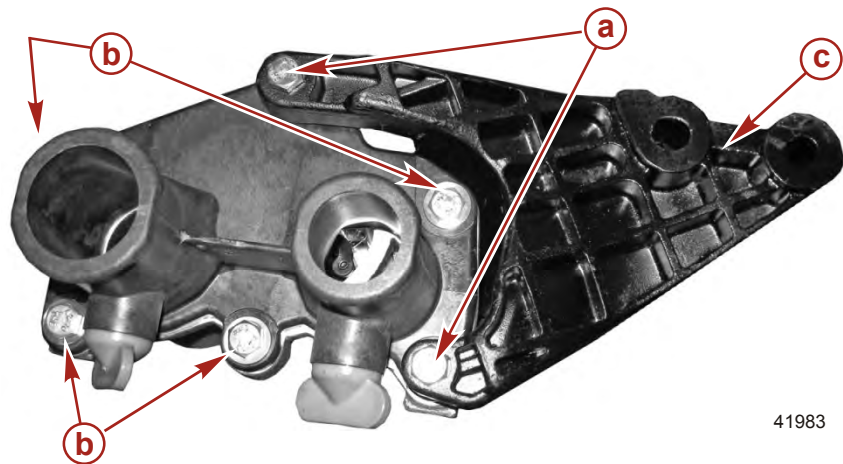


Seawater pump actuator housing is not shown
a - Impeller housing cover
b - Seawater pump

14. Apply Loctite 242 to the threads of the impeller housing cover or the seawater pump actuator housing screws.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw threads	92-809821

15. Install the four screws and tighten to specification.



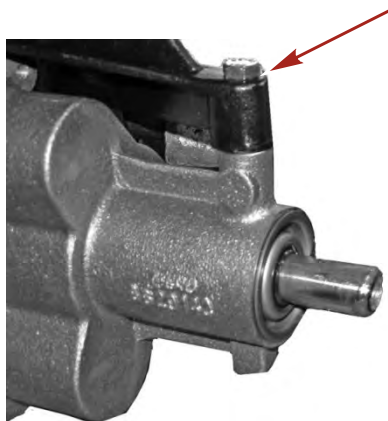
a - Seawater pump bracket screw (2)
b - Impeller housing cover screw (4)
c - Seawater pump bracket

Description	Nm	lb-in.	lb-ft
Impeller housing cover or seawater pump actuator housing screws	10	88	

16. Install the seawater pump bracket onto the seawater pump assembly. Install the two long screws through the bracket and into the seawater pump assembly. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Seawater pump bracket to seawater pump assembly screws	10	88	

17. Apply Loctite 242 to the threads of the remaining seawater pump bracket screw that attaches the seawater pump bracket to the top of the seawater pump assembly. Install and tighten the screw to specification.



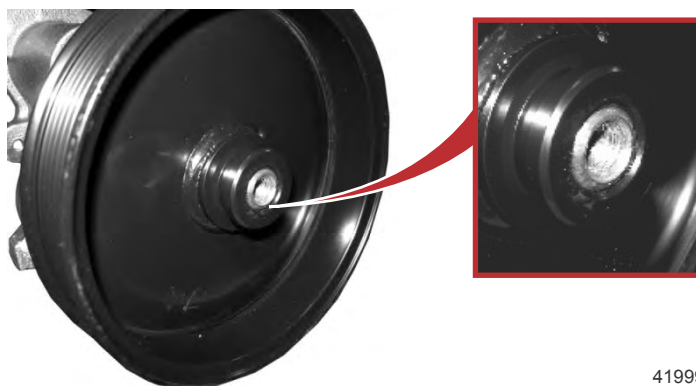
41985

Seawater pump bracket long screw

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw threads	92-809821

Description	Nm	lb-in.	lb-ft
Seawater pump bracket to seawater pump assembly screws	10	88	

18. Lubricate the seawater pump shaft with clean engine oil, and install the seawater pump pulley onto the shaft using an appropriate pulley installer. Ensure that the end of the shaft is even with the face of pulley hub.



41999

Seawater pump pulley installed

Tube Ref No.	Description	Where Used	Part No.
 139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Seawater pump shaft	92-858052K01

Pulley Pusher Installer	91-93656A1
Power Steering Pump Pulley Remover	SPX J-21239

19. Install the blue drain plugs in the seawater pump cover or actuator housing, if removed.

Installation

1. Fasten the seawater pump and bracket to the engine. Tighten the bolts to specification.

Description	Nm	lb-in.	lb-ft
Seawater pump bracket bolt	40		30

2. Install the seawater inlet and outlet hoses. Tighten the hose clamps securely.
 3. For models equipped with an air-actuated drain valve:
 - a. Install the vent hose onto the top of the drain valve.
NOTE: The air lines for the air-actuated drain valve are two different sizes.
 - b. Install the appropriate air lines into the appropriate fittings on the air-actuated drain valve by fully inserting the air lines into the fittings. Pull on the air lines to ensure that they are properly installed.
- IMPORTANT:** If a belt is to be reused, it should be installed in the same direction of rotation as before.
4. Install the serpentine drive belt.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

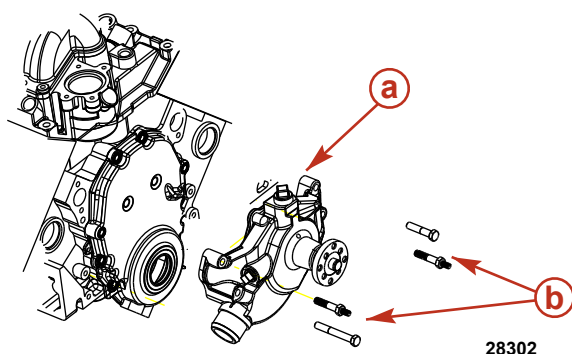
5. Supply cooling water to the engine.
6. Start the engine and check for leaks.

Water Circulating Pump

Removal

NOTE: The water circulating pump pulley on warm manifold models with closed cooling is a new design and cannot be replaced with a previous Mercury MerCruiser water circulating pump pulley.

1. Allow the engine to cool.
2. Drain the seawater or closed-cooling section of the engine.
3. Remove the hoses attached to the water circulating pump.
4. With the drive belt installed to prevent rotation, loosen the water circulating pump pulley bolts.
IMPORTANT: If a belt is to be reused, it must be installed in the same direction of rotation as before.
5. Mark the direction of belt rotation and remove the serpentine drive belt.
6. Remove the water circulating pump bolts and pulley.
7. Remove the fasteners and the water circulating pump.



- a - Water circulating pump
- b - Fasteners

Cleaning and Inspection

1. Clean all gasket material and sealant from the sealing surfaces.
2. Check the bearing for excessive play.
3. Check the bearing for abnormal noise when turning the shaft.
4. Check the pump body for cracks.
5. Check the seal for signs of leaking.

Installation

1. Coat both sides of the new water circulating pump gaskets and the threads of the attaching fasteners with Perfect Seal.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Water-circulating pump gasket and the threads of the attaching fasteners	92-34227Q02

2. Install the new water circulating pump gaskets onto the cylinder block.
3. Install the water circulating pump. Tighten the bolts to specification.

Description	Nm	lb-in.	lb-ft
Water circulating pump fasteners	47		35

4. Install the water circulating pump pulley onto the water circulating pump. Tighten the bolts securely.
5. Reconnect the hoses to the water circulating pump. Tighten the hose clamps securely.
6. Install the serpentine drive belt and adjust the belt tension.
7. Fill the closed-cooling system, if equipped.

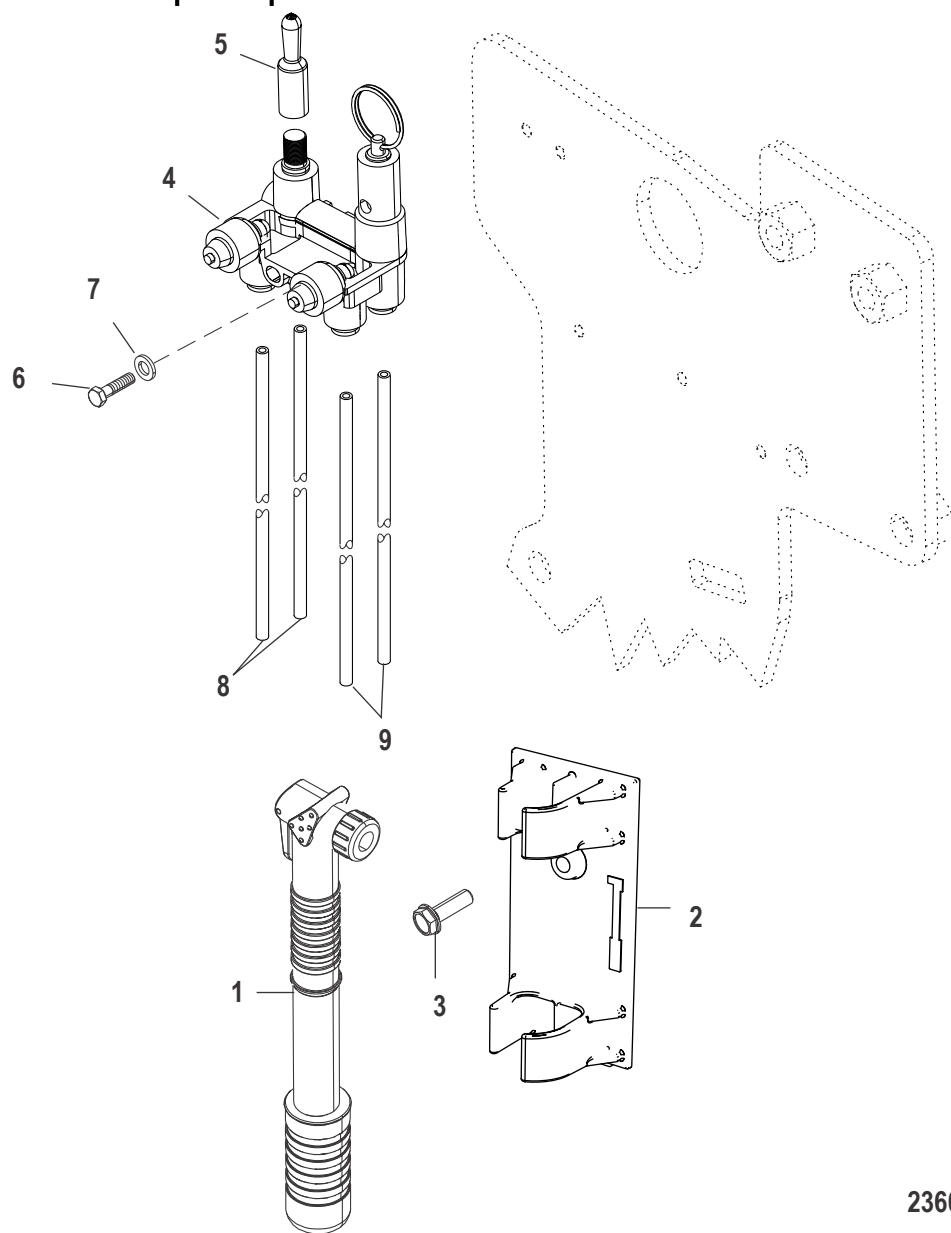
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

8. Supply cooling water to the engine.
9. Start the engine and check for leaks.

Air-Actuated Drain System

Air Manifold and Air Pump—Exploded View



2360

Air Manifold and Air Pump—Exploded View

Ref. No.	Qty.	Description
1	1	Pump
2	1	Air pump bracket
3	1	Screw
4	1	Air manifold assembly
5	1	Service point cap
6	2	Screw
7	2	Washer
8	2	Green air hose (color may differ in later production models)
9	2	Gray air hose (color may differ in later production models)

General Information

The air-actuated drain system uses compressed air to move a piston that pulls a plug out of a drain port or moves a drain tube to expose a hole to a water passage allowing water to drain into the engine compartment. All of the drain locations are arranged to allow any debris to be continually flushed away from the drains during normal engine operation. A feedback mechanism provides positive indication of proper piston movement. When each piston moves far enough in its cylinder, a port is uncovered that allows compressed air to flow back to the air manifold and cause the green indicator to extend. The drains are closed by opening the manual release valve that releases the compressed air from the system. The manual release valve also functions as an automatic pressure relief valve that opens at approximately 482.7 kPa (70 psi), thereby protecting the compressed air circuit from damage due to excess pressure.

Testing

⚠ CAUTION

Water can enter the bilge when the drain system is open, damaging the engine or causing the boat to sink. Remove the boat from the water or close the seacock, disconnect and plug the seawater inlet hose, and ensure the bilge pump is operational before draining. Do not operate the engine with the drain system open.

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

1. Remove the boat from the water.
2. Using the hand pump or other air source, pump air into the system until both of the green indicators extend and the manual release valve opens to relieve excess pressure. If one or both of the green indicators have not extended when the relief valve opens, the corresponding air-actuated drain valve has not opened and may be seized.
3. Release the compressed air from the air circuit by pulling up on the manual release valve ring.
4. Ensure both of the air-actuated drain valves have closed by verifying that water is no longer draining from either valve. If water continues to drain from an air-actuated drain valve after the air pressure has been released, the valve is seized and must be replaced.

Air Manifold

Removal

1. Remove the air manifold assembly from the air manifold bracket. Retain the washers and screws.
NOTE: The air lines are arranged in pairs of one gray and one green air line for each drain valve. To avoid reconnecting these hoses incorrectly, note which side of the air manifold each pair of air lines is connected to before removing them from the air manifold.
2. Disconnect the air lines from the air manifold. Push in and hold the plastic ring around the air line and pull the air line out of the fitting.

Installation

1. Connect each pair of air lines to the proper side of the air manifold by fully inserting the air lines into the fittings on the air manifold.
2. Install the air manifold assembly onto the air manifold bracket using the washers and screws. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Air manifold assembly to bracket screw	5	44	–

3. Test the drain system for proper operation.

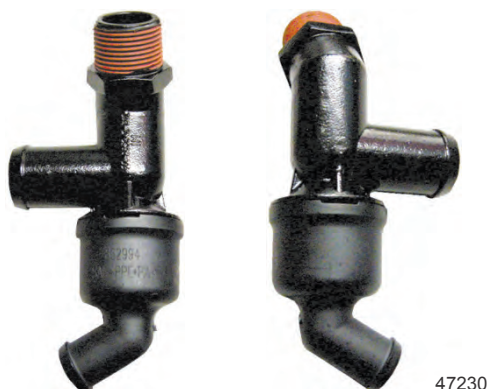
Exhaust Manifold Drain Check Valve

General Information

Engines with 3-point drain, single-point drain, and air-actuated drain systems are equipped with drain check valves on the exhaust manifolds.

- The check ball within the valve is forced upward by water pressure from the seawater pump. This seals the drain fitting.

- When there is no water pressure from the seawater pump, such as when the engine is off, the check ball falls down into the grooved drain fitting. This allows water to drain from the exhaust manifold and elbow.

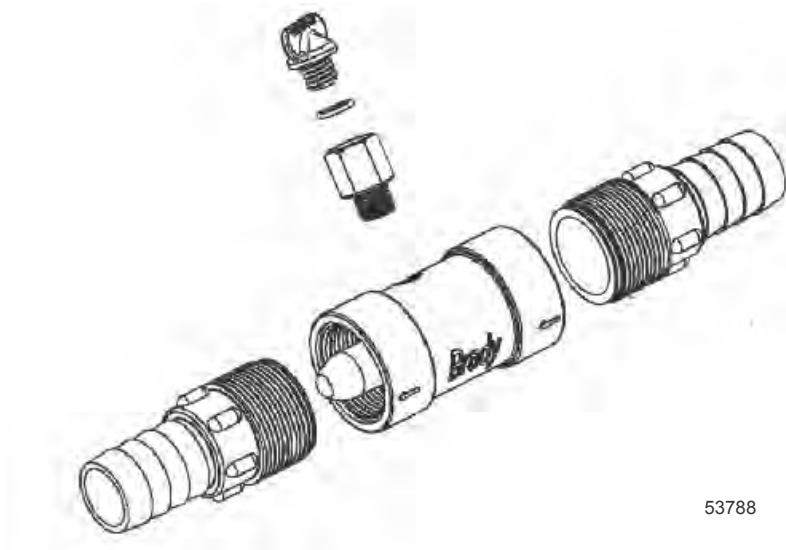


47230

Check Valve

General Information

A check valve is located in the water supply hose between the power steering cooler and the cool fuel cooler. The check valve prevents hot water from settling in the fuel cooler and causing fuel to vaporize when the engine is turned off.



53788

4.3L MPI with multipoint drain, S/N 0M300000 and above



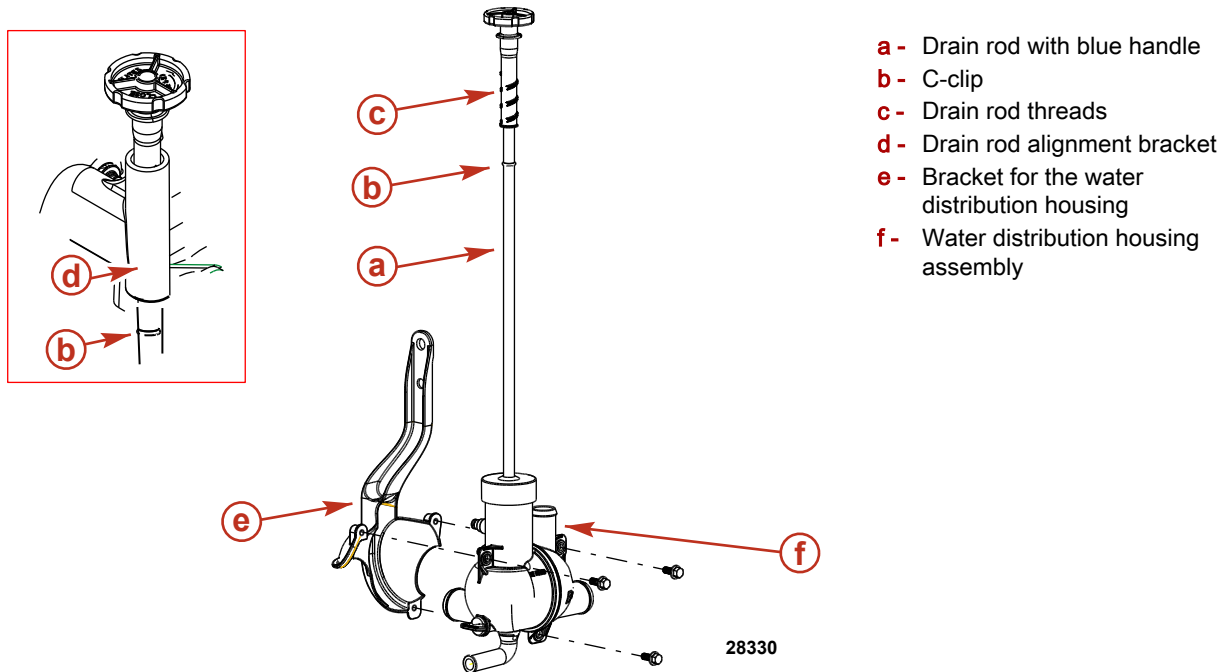
53789

4.3L MPI with closed cooling and easy drain, S/N 0M300000 and above

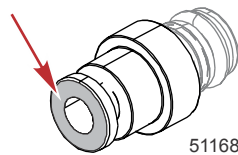
Water Distribution Housing

Removal

1. Drain the seawater section of the cooling system.
2. On an Alpha manual single-point drain, remove the drain rod from the water distribution housing.
 - a. Remove the C-clip from the drain rod. Retain the C-clip.
 - b. Turn the drain rod handle counterclockwise until the drain rod threads clear the alignment bracket. Pull the drain rod straight up to remove.



3. On an air-actuated single-point drain, remove each air line from the water distribution housing by pressing on the air valve fitting's release location and pulling the line out.



Release location on the air valve fitting

4. Disconnect the hoses from the water distribution housing.
5. Remove the bolt and nut attaching the water distribution housing and bracket to the engine.
6. Remove the bracket from the water distribution housing.

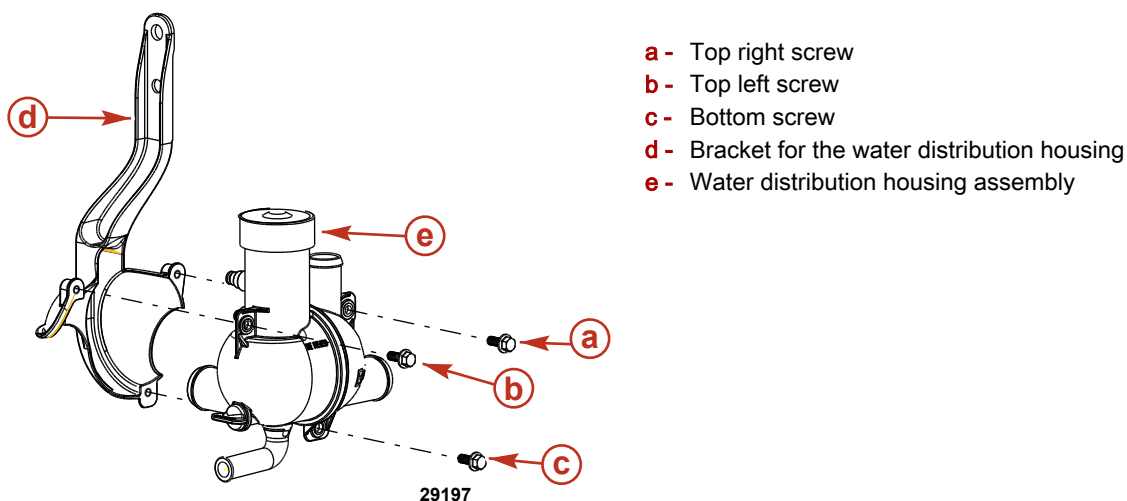
Cleaning and Inspection

1. Clean the water distribution housing with water and dry with a clean cloth or compressed air.
2. Inspect the housing for leaks, cracks, or corrosion damage. Replace, if necessary.

Installation

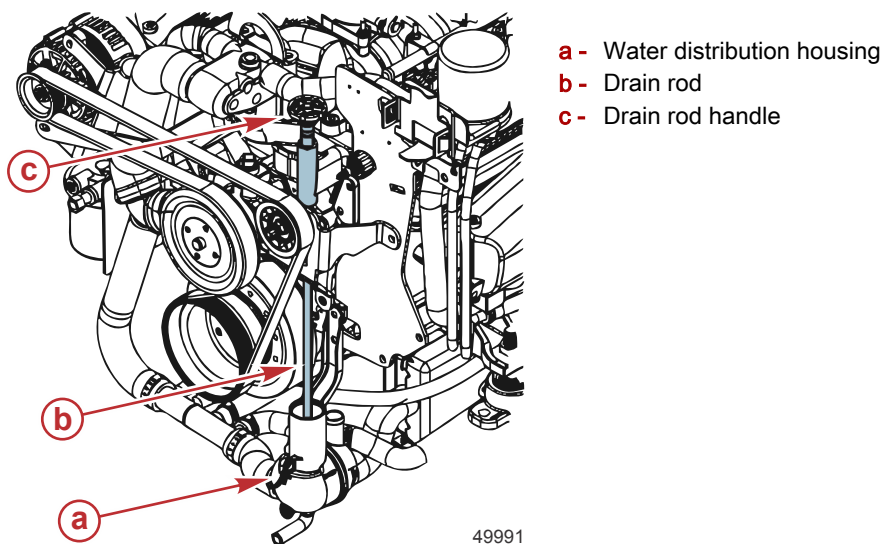
1. Align the water distribution housing with the bracket.
2. Install and tighten the screws to specification in the order listed.
 - a. Top right screw
 - b. Top left screw

c. Bottom screw

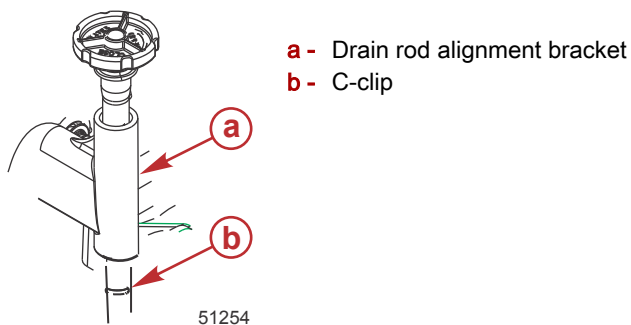


Description	Nm	lb-in.	lb-ft
Water distribution housing bracket screws	13	120	

3. Install the bracket and water distribution housing to the engine. Do not tighten the bolt and nut at this time.
4. On a manual single-point drain:
 - a. To obtain correct alignment, leave the hoses disconnected from the water distribution housing during installation.
 - b. Position the water distribution housing assembly to align with the drain rod.
 - c. Insert the drain rod into the water distribution housing to complete the alignment.



- d. Ensure that the rod is correctly aligned. The rod must screw in and out of the water distribution housing easily and with minimal pressure.
- e. Install the C-clip onto the drain rod.



5. Tighten to specification the bolt and nut that secure the water distribution housing bracket to the engine.

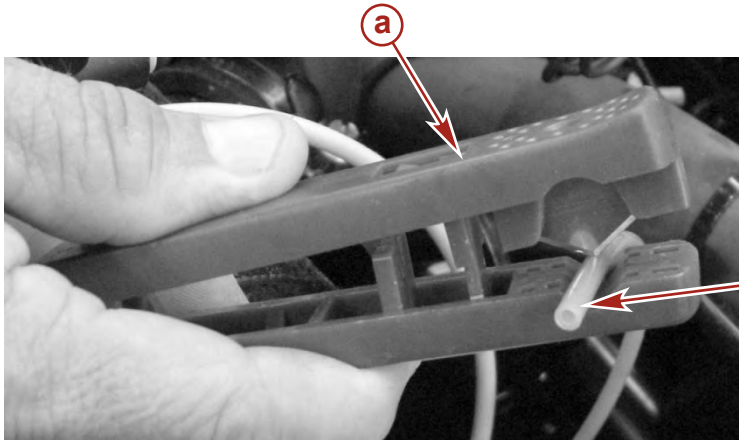
Description	Nm	lb-in.	lb-ft
Water distribution housing bracket bolt and nut	38		28

6. On an air-actuated single-point drain, connect the air lines to the air manifold.

IMPORTANT: Ensure that the air lines are routed to avoid sharp bends and contact with moving parts.

NOTE: The air line must remain cylindrical. The air line must not be distorted when cut. The end of the air line must be within 1 mm (0.04 in.) of square.

- a. Using an air line cutter, cut the bulk air line to the appropriate length.

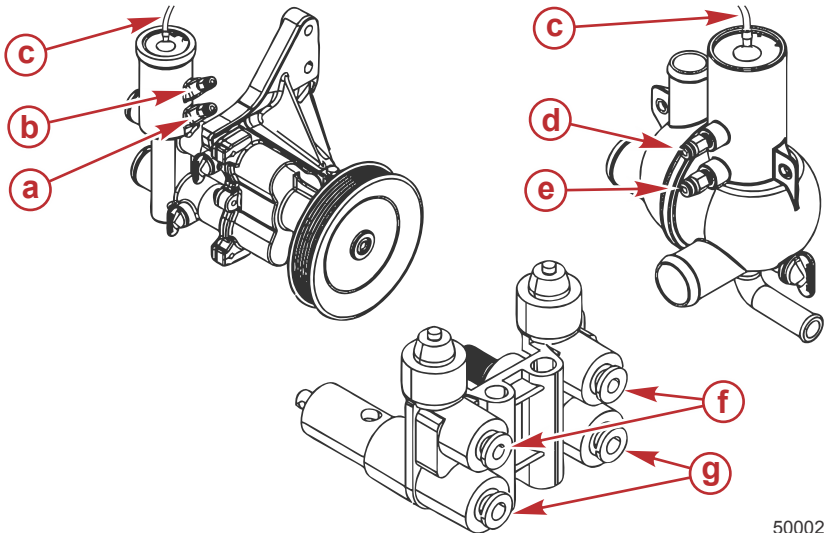


42000

- a - Air line cutter
b - Air line

Air Line Cutter	91-883502
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- b. Connect the air lines from the air manifold assembly to the seawater pump connectors and the water distribution housing connectors by inserting the end of the air lines approximately 6 mm (1/4 in.) onto the connectors.
- c. Connect the 3/16 in. O.D. air lines into the lower connectors on the air manifold, the water distribution housing, and the seawater pump.
- d. Connect the 5/32 in. O.D. air lines into the upper line connectors on the air manifold, the water distribution housing, and the seawater pump.
- e. Connect the 5/16 in. O.D. vent tube onto the water distribution housing air actuator. Secure the tube with cable ties.



50002

- a - Lower seawater pump air actuator air line connector (3/16 in.)
b - Upper seawater pump air actuator air line connector (5/32 in.)
c - Vent tubing connection (5/16 in.)
d - Upper water distribution housing air actuator air line connector (5/32 in.)
e - Lower water distribution housing air actuator air line connector (3/16 in.)
f - Upper air manifold assembly air line connector (5/32 in.)
g - Lower air manifold assembly air line connector (3/16 in.)

7. Pull on the lines to ensure that each air line is securely connected.
8. Secure the air lines with cable ties.
9. Connect the hoses to the water distribution housing. Securely tighten the hose clamps.

Cooling System

Section 6B - Models With Seawater Cooling

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Specifications

Seawater-Cooling System Capacity

Engine	Capacity
4.3L Models with seawater cooling	20 L (21 US qt)

Thermostat

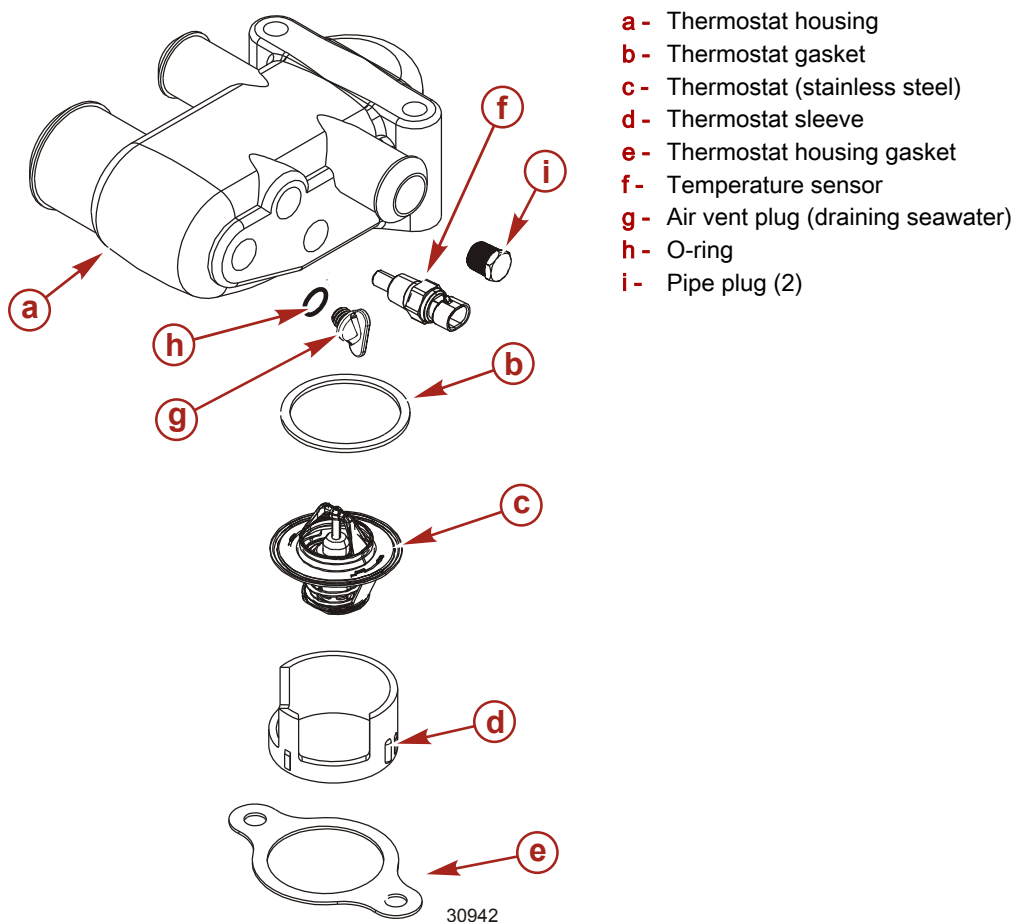
Engine	Specification
4.3L Models with seawater cooling	71° C (160° F)

Thermostat Assembly—Exploded View

Seven-Point Manual Drain Systems

Models Covered	Serial Number or Year
MPI	0M300000—0M614999

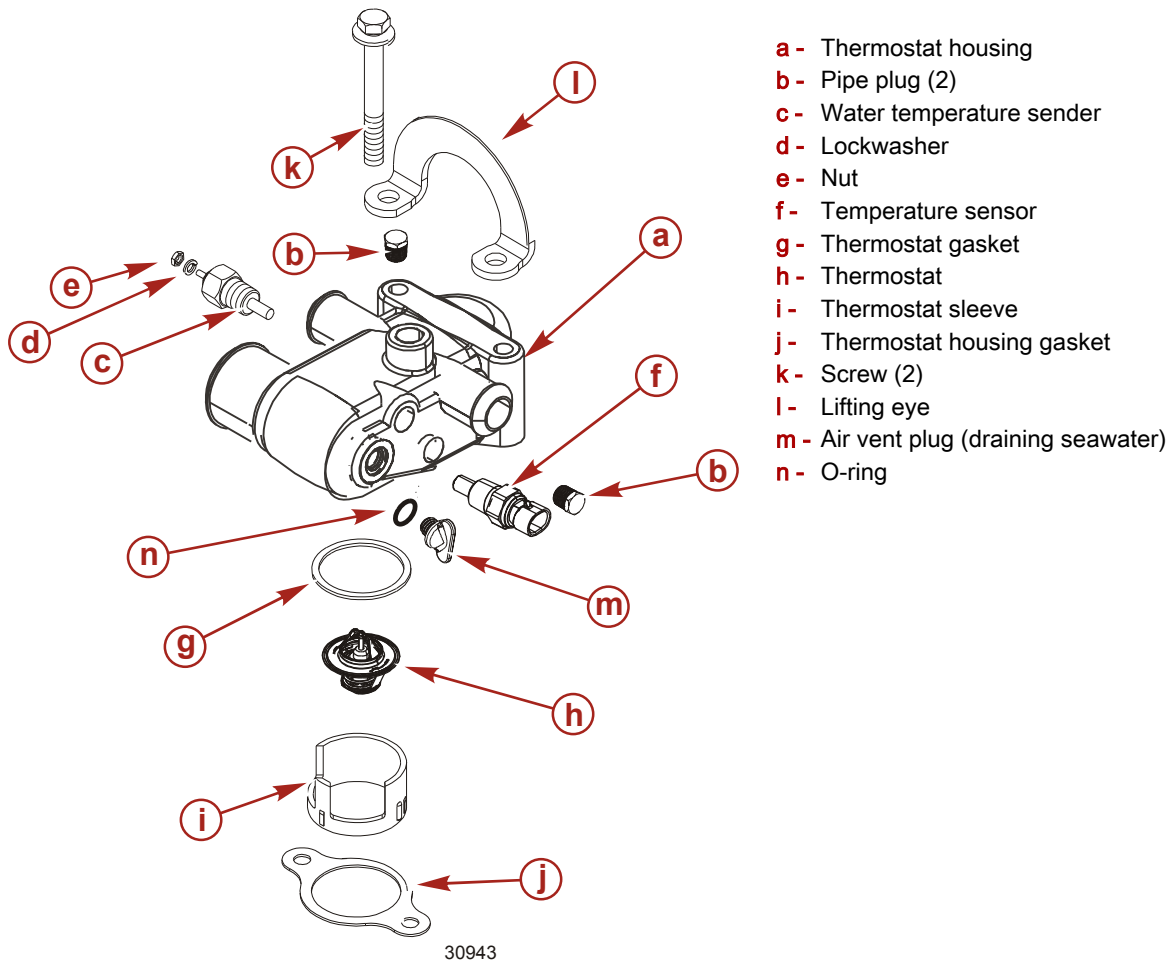
NOTE: A part number, 860256C3, is located on the thermostat housing casting as an identifier.



MPI Single-Point and Manual Three-Point Drain Systems

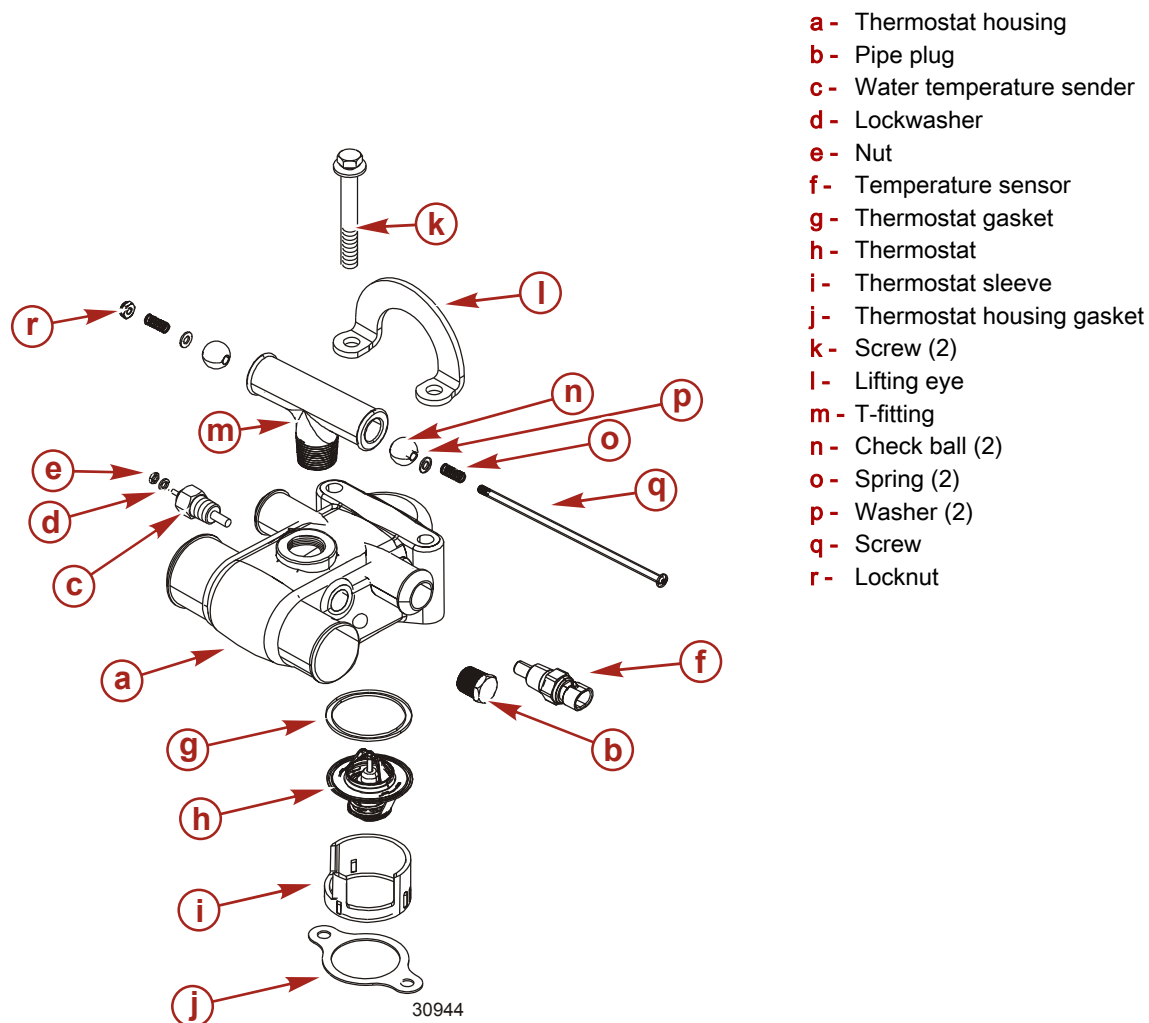
Models Covered	Serial Number or Year
MPI Sterndrive models	0M615000 and above

NOTE: A part number, 863457C, is located on the thermostat housing casting as an identifier.



Multi-Point and Seven-Point Drain Systems

Models Covered	Serial Number or Year
MPI sterndrive models	0M615000 and above
TKS sterndrive models	



- a - Thermostat housing
- b - Pipe plug
- c - Water temperature sender
- d - Lockwasher
- e - Nut
- f - Temperature sensor
- g - Thermostat gasket
- h - Thermostat
- i - Thermostat sleeve
- j - Thermostat housing gasket
- k - Screw (2)
- l - Lifting eye
- m - T-fitting
- n - Check ball (2)
- o - Spring (2)
- p - Washer (2)
- q - Screw
- r - Locknut

Torque Specifications

Multi-Point Drain Systems

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake manifold screws	41	–	30

Later Models With Single-Point and Manual Three-Point Drain Systems

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake manifold screws	33	–	24

Thermostat Assembly

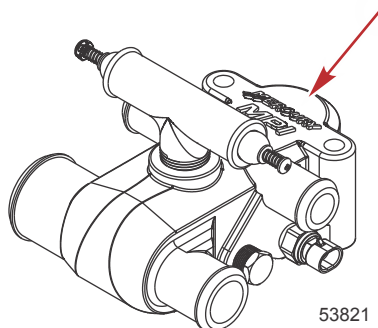
Thermostat Casting Identification

Visual identification of the later model multi-point drain system thermostat housings with the T-fitting assembly is determined by the logo or the part number on each casting.

MPI Models

NOTE: The "Mercury MPI" identifies machined tolerances for the engine models equipped with the MPI intake manifolds.

Models Covered	Serial Number or Year
MPI Sterndrive	0M615000 and above

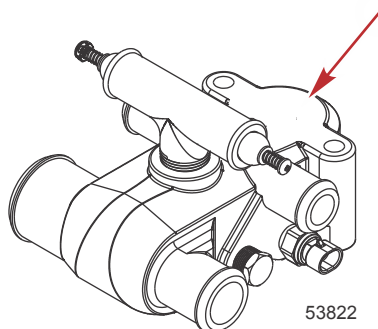


MPI thermostat housing with "Mercury MPI" casting mark

Carbureted Sterndrive Models

NOTE: No marking identifies machined tolerances for carbureted 4.3L TKS engine models.

Models Covered	Serial Number or Year
Carbureted Sterndrive	0M615000 and above



TKS thermostat housing without casting mark

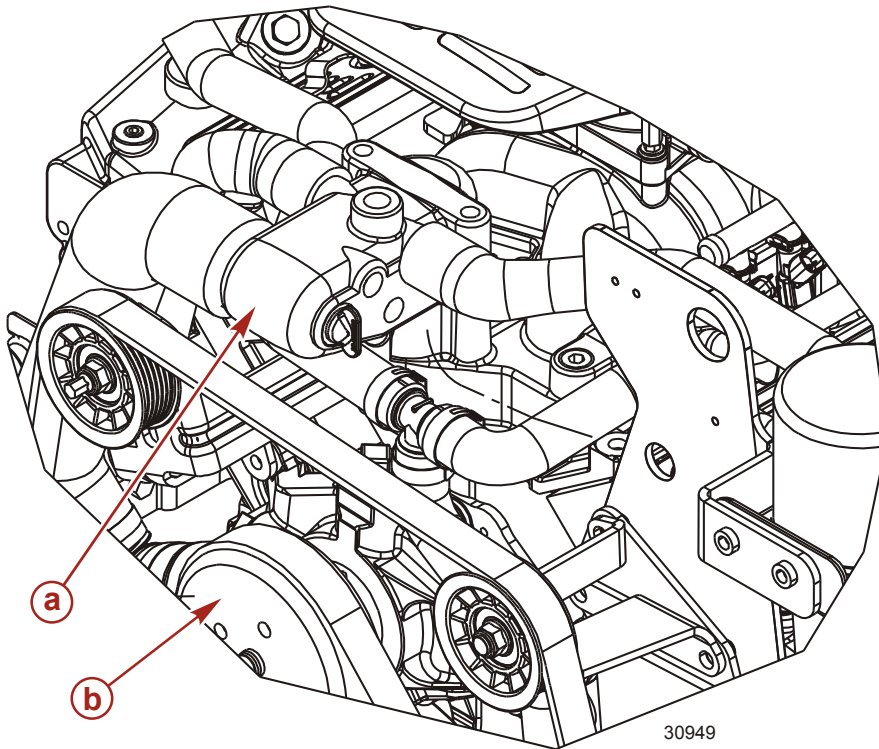
Removal

1. Drain the seawater from the engine.
2. Remove the hoses from the thermostat housing.
3. Remove the thermostat housing assembly.

4. Remove the sleeve, thermostat, and gasket from the thermostat housing.

Typical thermostat housing assembly; all models similar

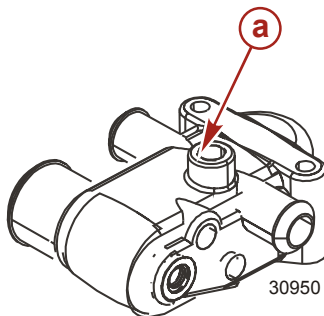
- a -** Thermostat assembly (lifting eye bracket not shown)
- b -** Engine water circulating pump



Inspection

Thermostat for Single-Point and Manual Three-Point Drain Systems

1. Ensure that the two air vent holes of the thermostat housing casting are not blocked.



- a -** Air vent holes location (inside raised area)

Thermostats With T-Fitting

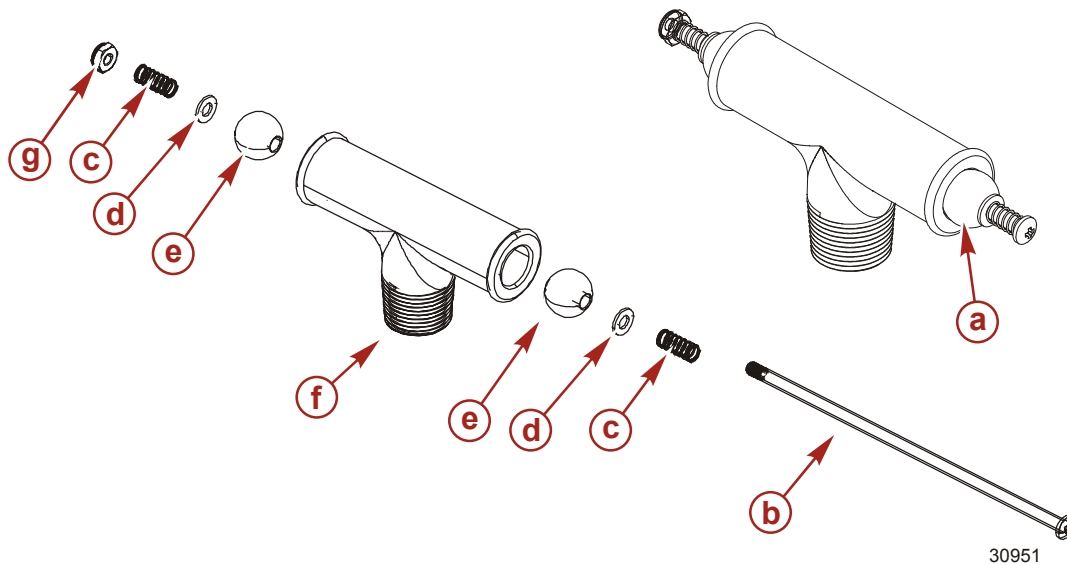
IMPORTANT: Prevent the engine from overheating. The T-fitting spring tension must be adequate to seat the check balls.

1. Inspect the check balls for proper seating to the T-fitting. If both check balls are not tight against the T-fitting, replace the springs.

IMPORTANT: Replace the check balls and the springs of the T-fitting if the engine overheats.

2. Remove the T-fitting nut and components.
3. Inspect the check balls of the T-fitting assembly for grooves, roundness, and worn areas. Replace it if it is damaged.

4. Assemble the components in order of removal. Secure with the nut.



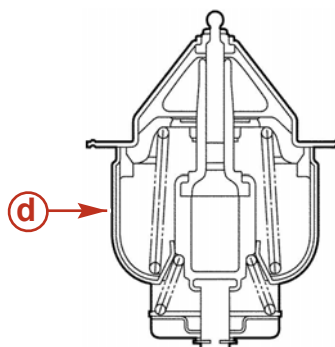
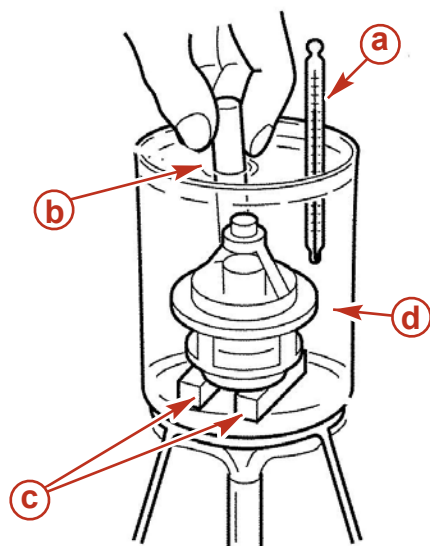
Typical T-fitting assembly

- a - Check ball to T-fitting location
- b - Screw
- c - Spring
- d - Washer
- e - Check ball
- f - T-fitting
- g - Nut

Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Completely submerge the thermostat in water.
4. Heat the water.
5. Stir the water constantly to avoid direct from heat being applied to the thermostat.
 - a. Check the thermostat initial opening temperature.

- b. Check the thermostat full opening temperature.



24421

Typical thermostat

- a - Thermometer
- b - Agitating rod
- c - Wooden blocks
- d - Thermostat

- c. Valve should have a minimum of 6.60 mm (0.260 in.) stroke at fully open position.

6. Replace if specifications are not met or damage is discovered during inspection.

Thermostat Valve Opening	Seawater Cooling	Closed Cooling
Initial opening test temperature	71° C (160° F)	76° C (170° F)
Full open test temperature	84° C (184° F)	89° C (192° F)

Installation

NOTE: Refer to the preceding exploded view for parts identification during assembly.

- Clean the gasket surfaces inside the thermostat housing, on the thermostat housing, and on the intake manifold.
- Place a new thermostat gasket in the thermostat housing. Ensure that it is positioned properly in the housing.
- Place the thermostat in the thermostat housing with the thermostatic element end toward the housing bottom.
- Align the sleeve with the groove in the thermostat housing bore and install the sleeve into the housing.
- Position a new thermostat housing gasket on the intake manifold.
- Install the thermostat housing and tighten the screws to specification.

Description	Nm	lb-in.	lb-ft
Thermostat housing screws	41	–	30

7. Connect the hoses to the thermostat housing. Tighten the hose clamps securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

- Supply cooling water to the engine.
- Start the engine and inspect for leaks.

T-Fitting for Water Hose Assembly

General Information

The colored O-ring on the lower leg of the T-fitting is a visual identification that the orifice bushing is used. Models that require the T-fitting without the orifice bushing do not use the colored O-ring.

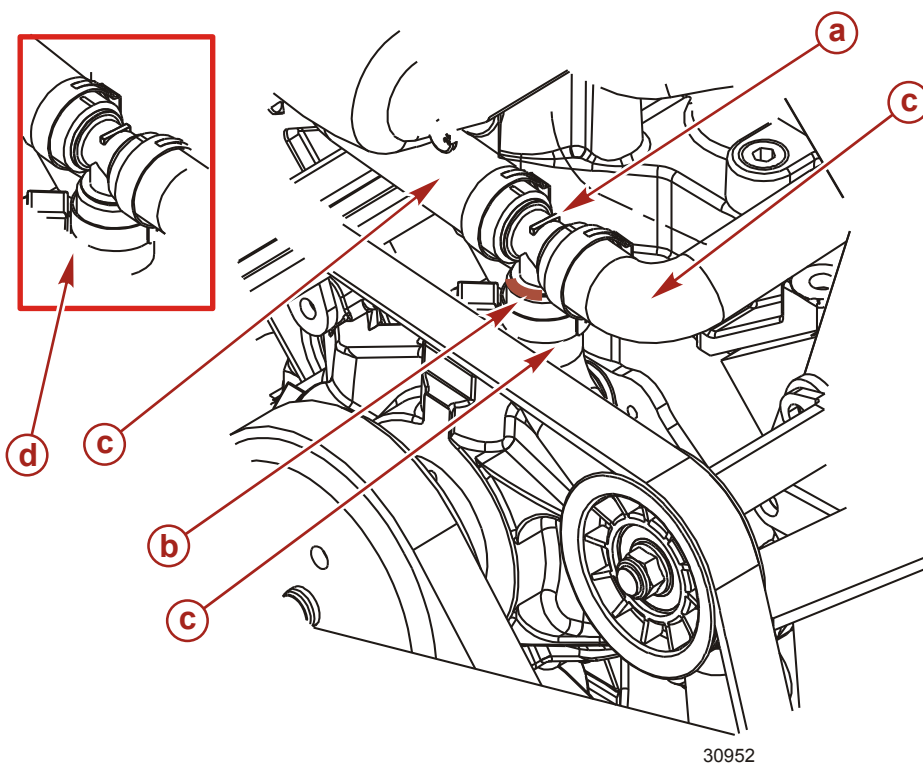
IMPORTANT: Overheating will occur if the orifice bushing is not installed.

IMPORTANT: The orifice bushing and O-ring are for use on seawater cooled Alpha models only. Do not use on Bravo models.

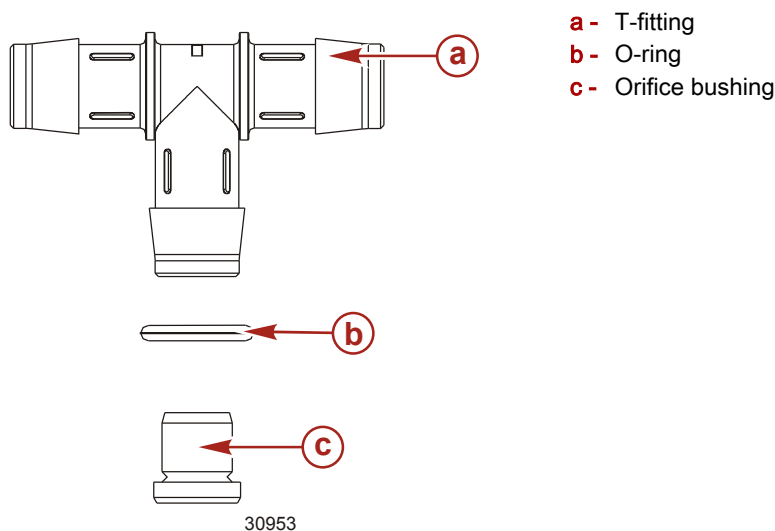
NOTE: The friction from the water distribution housing to T-fitting hose will retain the orifice bushing.

Removal

1. Remove the hose clamps.
2. Disconnect the water hoses from the T-fitting.



- Alpha models with orifice bushing: Remove the orifice bushing and the O-ring from the T-fitting.



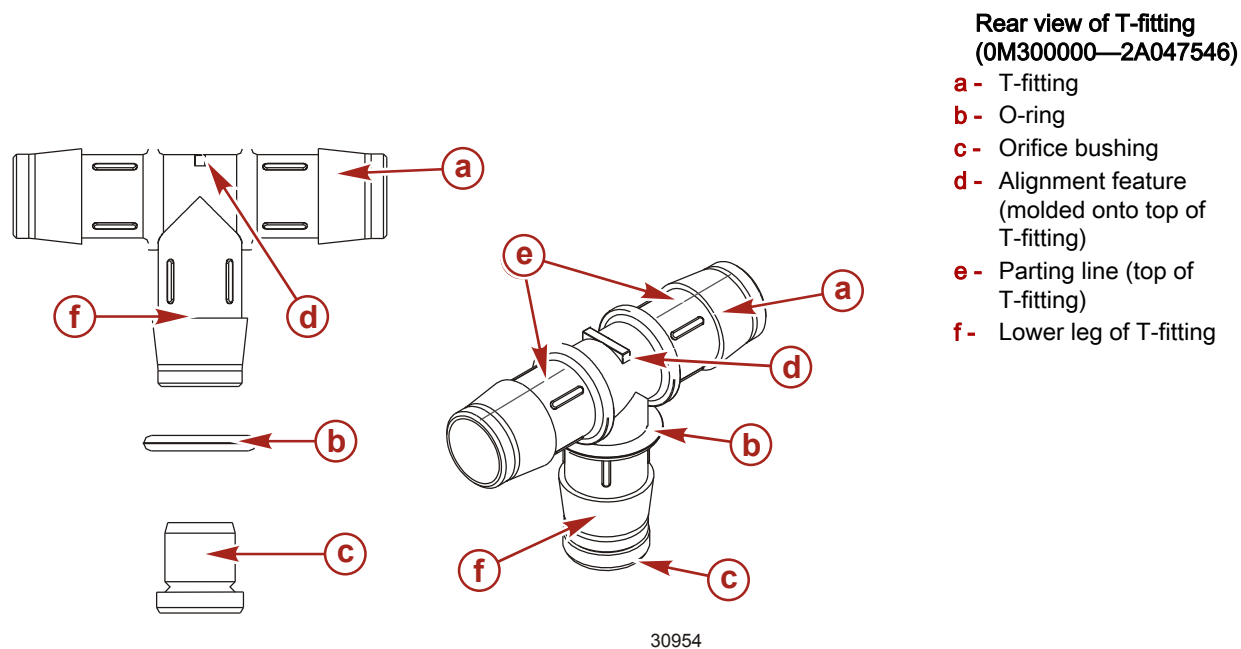
Cleaning and Inspection

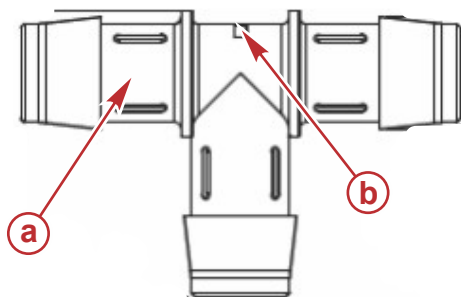
- Clean with soapy water.
- Inspect the T-fitting, orifice bushing, and O-ring, for damage.
- Replace any damaged parts.

Assembly—Alpha Models

IMPORTANT: Overheating will occur if the orifice bushing is not installed.

- Install the orifice bushing into the lower leg of the T-fitting.
- Place the O-ring onto the lower leg of the T-fitting.

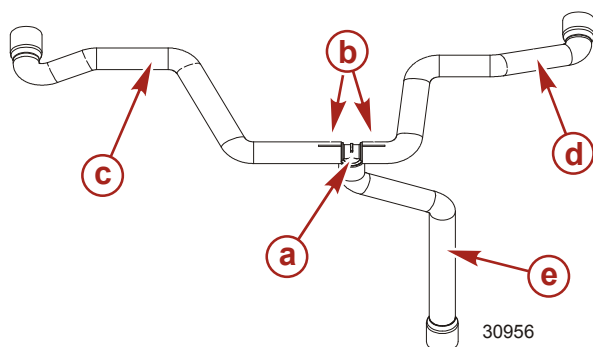


**T-fitting 2A047547 and above**

- a** - T-fitting (red)
- b** - Alignment feature (molded onto top of T-fitting)

53777

3. Align the marks on the hose to the alignment feature on the top of the T-fitting.
4. Align the marks on the hoses to the parting line on the T-fitting. Install the T-fitting to the port and starboard elbow hoses.
5. Tighten the hose clamps securely.



- a** - T-fitting
- b** - Alignment marks (on hose)
- c** - T-fitting to starboard elbow hose
- d** - T-fitting to port elbow hose
- e** - Water distribution housing to T-fitting hose

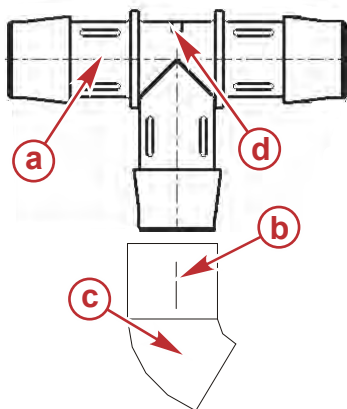
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IMPORTANT: Route the hoses to avoid contact with rotating components.

6. Route the water distribution housing to the T-fitting hose down through the tensioner pulley bracket, and connect it to the water distribution housing.
7. Connect the T-fitting to the port elbow hose to the hose fitting on the port exhaust elbow.
8. Connect the T-fitting to the starboard elbow hose to the hose fitting on the starboard exhaust elbow.
9. Tighten all the hose clamps securely.
10. Ensure that the O-ring is visible on the lower leg of the T-fitting.

Bravo Models

1. Align the marks on the hose to the alignment feature on the top of the T-fitting.
2. Install the T-fitting into the hose. Tighten the hose clamp securely.

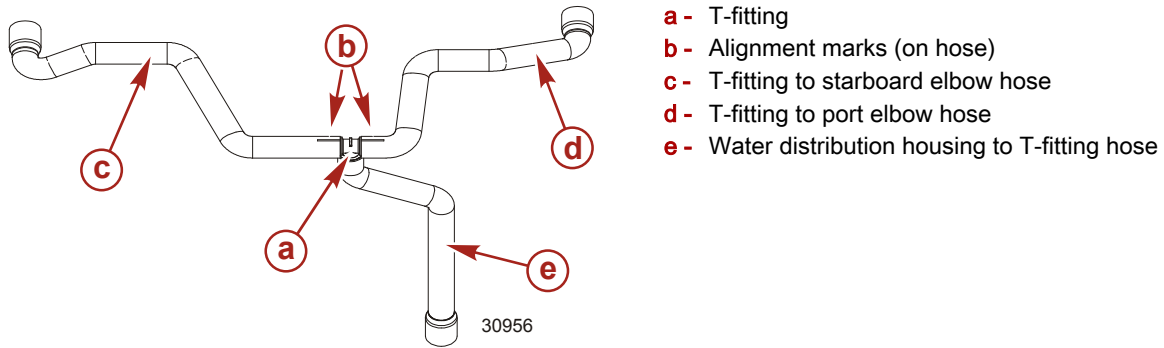
**Rear view of hose assembly**

- a** - T-fitting (black)
- b** - Alignment marks (on hose)
- c** - Water distribution housing to T-fitting hose
- d** - Alignment feature (molded onto top of T-fitting)

53779

3. Align the marks on the hoses to the alignment feature on the T-fitting. Install the T-fitting to the port hose and the T-fitting to starboard elbow hoses.

4. Tighten the hose clamps securely.



IMPORTANT: Route the hoses to avoid contact with rotating components.

5. Route the water distribution housing to T-fitting hose down through the tensioner pulley bracket and connect it to the water distribution housing.
6. Connect the T-fitting to port elbow hose to the hose fitting on the port exhaust elbow.
7. Connect the T-fitting to starboard elbow hose to hose fitting on starboard exhaust elbow.
8. Tighten all of the hose clamps securely

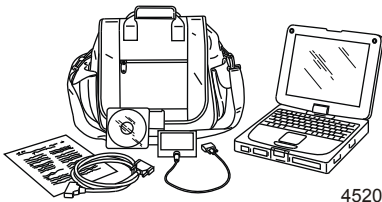
Cooling System

Section 6C - Models with Closed Cooling

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Special Tools

Computer Diagnostic System (CDS)	Bosch Automotive Service Solutions
	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: Bosch Automotive Service Solutions 28635 Mound Rd Attn: Powersport ASR Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

Specifications

Seawater Inlet Recommendations

Description	Specification
Minimum flow	106 L/min (28 gal/min) at 4000 RPM
Minimum pressure at full flow (If restrictions are present, the reading could be inaccurate.)	138 kPa (20 psi) at 4000 RPM

Closed-Cooling System Capacity

Description	Specification
Coolant volume in engine, heat exchanger, and exhaust manifolds	19.5 L (20.5 US qt)
Seawater volume in conduits and tube side of heat exchanger	4.3 L (4.5 US qt)

Coolant Specification

Description	Part Number
Extended Life Coolant 5/100 (orange color)	92-877770K1

Thermostat

Description	Specification
Thermostat operating temperature	77° C (170° F)

Pressure Cap

Description	Specification
Pressure cap rating	110 kPa (16 psi)

General Information

Description

The cooling system is composed of two separate subsystems: the seawater system and the closed-cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed-cooling system as it passes through the heat exchanger. The closed-cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into the recovery bottle is approximately 230 ml (7.8 fl oz) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. While there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

Within the heat exchanger, the coolant (antifreeze) flows around the outside of the cooling tubes, while seawater flows through the inside of the cooling tubes.

Full Loop Closed Cooling Systems

Full loop closed cooling systems use an ethylene glycol mixture to cool the engine and exhaust manifolds. The hot glycol mixture is circulated through the heat exchanger tubes, engine block, and exhaust manifold water jackets. Heat transfer occurs when cool raw water from the sea pump flows through the heat exchanger and is discharged into the exhaust stream at the exhaust elbows.

All current production MerCruiser engines equipped with closed cooling kits use full loop systems.

Half Loop Closed Cooling Systems

Half loop closed cooling systems use an ethylene glycol mixture to cool the engine block. The hot glycol mixture is circulated through the heat exchanger tubes and engine block water jackets. Heat transfer occurs when cool raw water from the sea pump flows through the heat exchanger and is discharged into the exhaust stream at the exhaust elbows.

NOTE: Refer to **Section 6D - Water Flow Diagrams** for full loop and half loop cooling system flow diagrams.

Sterndrive Models with Closed Cooling

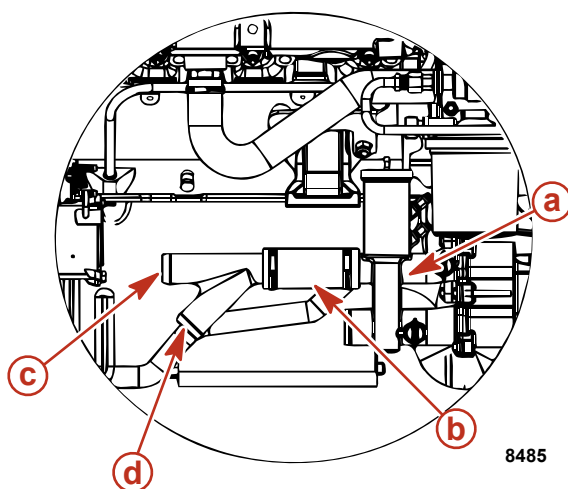
Alpha Models with Closed Cooling

Alpha sterndrive models with closed cooling are equipped with a seawater pump on the engine. However, a through-the-hull or through-the-transom seawater pickup is also required in order to meet the minimum flow specifications.

Bravo Models with Closed Cooling

NOTE: Bravo models with closed cooling require a through-the-hull or through-the-transom pickup in addition to the sterndrive water inlets in order to meet the minimum flow specifications.

When additional water inlets are used, a Y-fitting is installed into the engine seawater pump.



Dual seawater pickup for Bravo models with closed cooling

- a** - Engine seawater pump
- b** - 10 cm (4 in.) hose, from seawater pump inlet to Y-fitting port
- c** - Y-fitting port to water inlet at transom
- d** - Y-fitting port to through-the-hull or through-the-transom seawater pickup

Models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere do not require the dual seawater pickup with a Bravo sterndrive on closed cooling models.

Remove the Y-fitting at the seawater pump inlet. Install a seawater supply hose that meets MerCruiser specifications. Cut the hose to fit from the transom inlet fitting to the seawater pump inlet.

SeaCore Models

Some SeaCore models do not require a through-the-hull or through-the-transom seawater pickup to meet the minimum flow specifications. Refer to **Seawater Pickups for SeaCore Sterndrive Engine Models**.

SeaCore Bravo One and Bravo Three Models

The SeaCore Bravo One and Bravo Three engine packages do not require a through-the-hull or through-the-transom seawater pickup in addition to the sterndrive water pickups if:

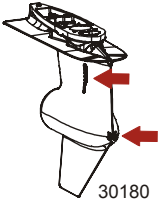
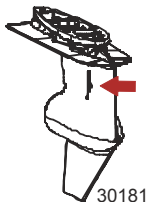
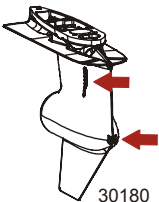
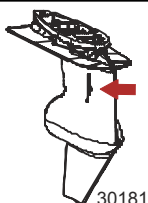
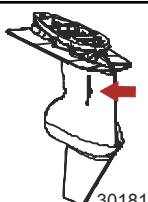
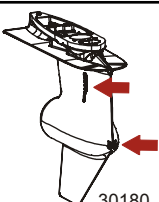
- The sterndrive gearcase has dual water pickups.
- The boat is capable of 64 km/h (40 mph) with the boat fully loaded and operated within the specified operating range.

NOTE: If a through-the-hull or through-the-transom seawater pickup is not to be installed, refer to **Installing the Seawater Supply Hose**.

SeaCore Bravo Two Models

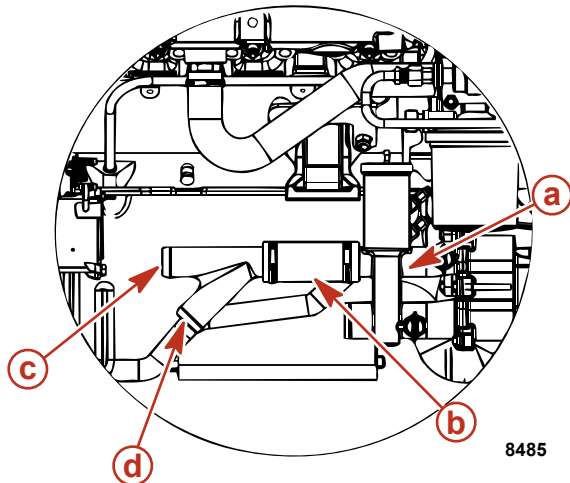
The SeaCore Bravo Two engine packages must have a through-the-hull or through-the-transom seawater pickup in addition to the sterndrive side water pickups. Install the Y-fitting at the engine's seawater pump inlet. Refer to **Installing the Y-Fitting**.

Seawater Pickups for SeaCore Sterndrive Engine Models

Boat speed with the boat fully loaded and operated within the specified operating range	SeaCore Bravo has side water pickup	SeaCore Bravo has dual water pickup	Through-the-hull or through-the-transom seawater pickup
64 km/h (40 mph) or greater			Not required. Refer to Installing the Seawater Supply Hose
Less than 64 km/h (40 mph)			Required. Refer to Installing the Y-Fitting
64 km/h (40 mph) or greater			Required. Refer to Installing the Y-Fitting
Any speed - Models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere.			Not required. Refer to Installing the Seawater Supply Hose

Installing the Y-Fitting

Engine models that require a through-the-hull or through-the-transom seawater pickup require a Y-fitting at the engine seawater pump inlet port. The Y-fitting directs the seawater from the sterndrive and through-the-hull or through-the-transom seawater pickup to the engine's seawater pump to meet the minimum flow specifications.



Typical Y-fitting installation

- a - Engine seawater pump
- b - 10 cm (4 in.) Hose, from seawater pump inlet to Y-fitting port
- c - Y-fitting port to water inlet at transom
- d - Y-fitting port to through-the-hull or through-the-transom seawater pickup

NOTE: For models not factory equipped with a Y-fitting, refer to **Mercury Parts Catalog, Closed-Cooling Systems (Bravo)** to order the specified Y-fitting, seawater supply bulk hose, and hose clamps that meet MerCruiser specifications.

1. Cut a 10 cm (4 in.) piece of the supply hose and connect it to the seawater pump inlet and the Y-fitting port.
2. Install a seawater supply hose onto the Y-fitting port and the sterndrive's water inlet at the transom. Cut off any excess hose.
3. Install a seawater supply hose onto the Y-fitting port and the through-the-hull or through-the-transom seawater pickup. Cut off any excess hose.
4. Properly secure all hoses to all fittings to prevent water leaking into the boat.

Installing the Seawater Supply Hose

For engine models not using a through-the-hull or through-the-transom seawater pickup:

1. If applicable, remove the Y-fitting at the seawater pump inlet.
2. Install a seawater supply hose that meets MerCruiser specifications to the engine's seawater pump inlet.
3. Route the seawater supply hose directly to the seawater inlet fitting on the transom. Cut off any excess hose.
4. Properly secure the hose at both ends to prevent water leaking into the boat.

NOTE: For models not factory equipped with a seawater supply hose, refer to the **Mercury Parts Catalog, Standard-Cooling Systems (Bravo)** to order the specified bulk hose, hose clamps, and quick-connect fittings that meet MerCruiser specifications.

NOTE: For models with quick-connection fittings, refer to **Bravo Seawater Inlet Fitting Connection** in **Section 2B**.

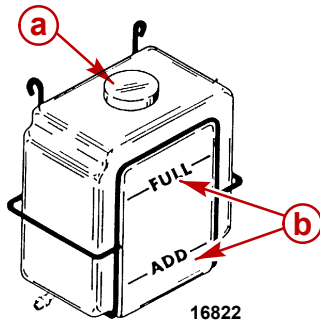
Coolant

Coolant Recommendations

IMPORTANT: Alcohol-based or Methanol-based antifreeze or plain water are not recommended for use in the closed-cooling section of the cooling system at any time.

NOTE: All factory installed closed-cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any top-off fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Coolant Level



Coolant recovery bottle

- a - Cap
- b - "ADD" and "FULL" marks

1. Before starting the engine, ensure that coolant is visible in the coolant recovery bottle.
2. If coolant is not visible:
 - a. Check the closed-cooling system (including the coolant recovery system) for leaks.
 - b. Make any necessary repairs.
 - c. Refill the system with the recommended coolant solution.
3. If coolant is visible:
 - a. Start the engine and operate it until it reaches its normal operating temperature.
 - b. Check the coolant level in the coolant recovery bottle. The coolant level must be between the "ADD" and "FULL" marks on the front of the bottle.
 - c. If the coolant level is low, remove the fill cap from the coolant recovery bottle and add the required amount of coolant solution. Refer to **Coolant Recommendations**.

⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

4. Occasionally, ensure that the coolant recovery system is functioning properly by removing the pressure cap from the heat exchanger and checking the level. The coolant level should be up to the bottom of the heat exchanger filler neck. If it is low, examine the entire closed-cooling section (especially the coolant recovery system) for leaks, and make any necessary repairs.

IMPORTANT: When reinstalling the pressure cap, tighten it until it contacts the stops on the filler neck.

Pressure Cap Maintenance and Testing

IMPORTANT: Replace the pressure cap if the engine overheats.

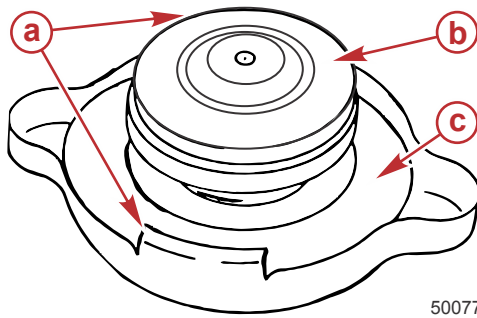
The pressure cap is designed to maintain a pressure of approximately its rated capacity once the engine has attained operating temperature. The cap should be cleaned, inspected, and pressure-tested at regular intervals or whenever the cap is suspected of not maintaining the proper pressure.

⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

1. Carefully remove the pressure cap from the reservoir or the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the gasket (if equipped) and the rubber seal on the cap for tears, cuts, cracks, or other signs of deterioration. Replace the gasket, if damaged.
4. Replace the cap if the rubber seal is damaged.

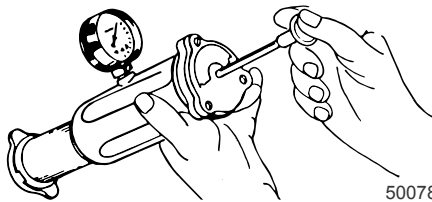
5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.



- a - Locking tabs (one not shown)
b - Rubber seal
c - Gasket

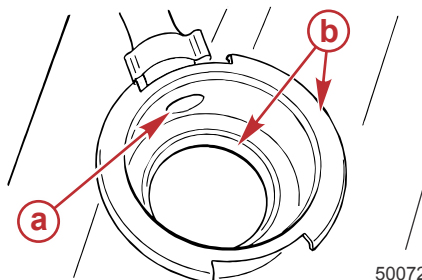
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6. Using a cooling system pressure tester, test the cap to ensure that it releases at the proper pressure and does not leak. Refer to the tester instructions. The cap must relieve pressure at 110 kPa (16 psi) and must hold the rated pressure for 30 seconds without going below 75.8 kPa (11 psi). Replace the cap if it fails to fall within these limits.



50078

IMPORTANT: Before installing the cap, examine the lower inside sealing surface in the filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect the cam lock flanges on the sides of the filler neck to ensure that they are not bent.



- a - Coolant recovery passage
b - Sealing surfaces

50072

7. Install the cap on the reservoir or the heat exchanger.

Testing the Closed-Cooling System

Testing Coolant for Alkalinity

⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

The coolant should be changed per the maintenance schedule (refer to **Section 1C - Maintenance**) and should be checked for alkalinity at least once between change intervals. To check the coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local source.
2. Allow the engine to cool, remove the pressure cap from the heat exchanger, and insert one end of the litmus paper into the coolant.
3. If the pink litmus paper turns blue, the coolant is alkaline and does not need to be replaced.
4. If the pink litmus paper remains pink, the coolant is not alkaline and must be replaced. Refer to **Changing Coolant**.

Pressure Testing the System

⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

Models with Closed Cooling

If the coolant section of the closed-cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove the pressure cap from the heat exchanger or the reservoir.
2. Clean, inspect, and pressure test the pressure cap.
3. Clean the inside of the filler neck to remove any deposits or debris.
4. Examine the lower inside sealing surface for damage. The surface must be perfectly smooth to achieve a good seal between it and the rubber seal on the cap.
5. Ensure that the locking cams on the sides of the filler neck are not bent or damaged.
6. Adjust the coolant level to 25 mm (1 in.) below the filler neck.
7. Attach an automotive-type cooling system pressure tester to the filler neck and pressurize the closed-cooling section to amount specified.

Pressure Cap Rating	Amount of Pressure Applied to Closed-Cooling System
110 kPa (16 psi)	138 kPa (20 psi)

8. Observe the gauge reading for approximately two minutes; the pressure should not drop during this time. If the pressure drops, proceed with the following steps until leakage is found.
9. While maintaining the specified pressure on the closed-cooling section, inspect the external portion of the cooling system (for example, hoses, gaskets, drain plugs, petcocks, core plugs, and circulating pump seal) for leakage. Also listen closely for bubbling or hissing.
10. Test the heat exchanger.

Seawater Pressure Test

IMPORTANT: This test applies only to models with closed cooling.

IMPORTANT: The boat must be in the water for this test.

1. Connect the computer diagnostic system (CDS).

Computer Diagnostic System (CDS)	Bosch Automotive Service Solutions
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2. Start the engine. When the engine is at normal operating temperature, shift into forward gear.
3. Advance the throttle to 4000 RPM.
4. Check the seawater pressure with CDS. If the seawater pressure does not meet specification, further testing is required.

Description	Specification
Minimum pressure (models with closed cooling)	138 kPa (20 psi) at 4000 RPM

5. If no leakage could be found in the above steps, the engine is leaking internally. Leaking may be caused by one or more of the following:
 - Loose cylinder head bolts or damaged gasket
 - Loose intake manifold bolts or damaged gasket
 - Loose exhaust elbow or distribution block retaining nuts or damaged gasket
 - Cracked or porous cylinder head or block
 - Cracked or porous exhaust manifold
6. Proceed as follows until the location of the internal leak is found.
 - a. Start the engine.
 - b. Pressurize the system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, the compression or the combustion is leaking into the closed-cooling section from a leak in the combustion chamber.
 - c. Stop the engine.
 - d. Remove the spark plugs, examining each for the presence of coolant. A spark plug that is perfectly clean or has a milky appearance is an indication of an internal leak.
 - e. Drain the oil from the engine and examine it for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove the engine from the boat and remove the oil pan. With the engine in the upright position, repressurize the closed-cooling section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.
 - f. If no leakage can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

Testing for a Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

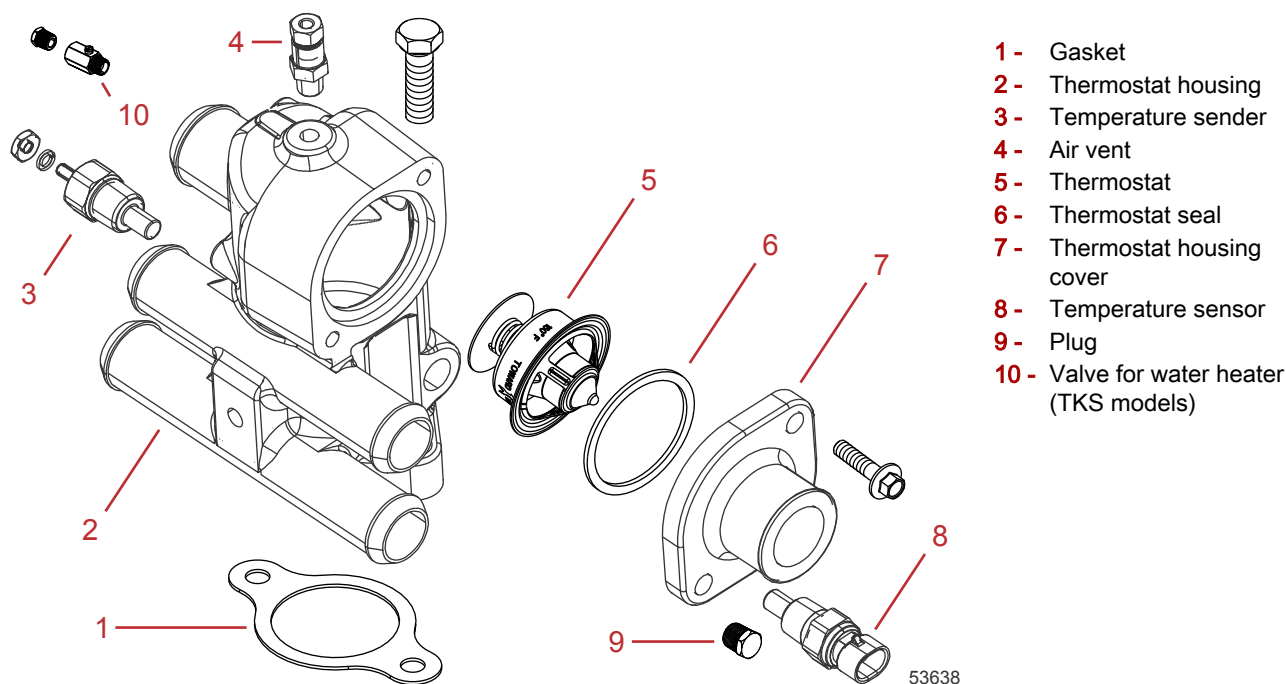
IMPORTANT: Operate the boat in the water for this test. It is best to operate the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and the coolant recovery bottle. Use a 91 cm (3 ft) long hose for this test.
2. Route this hose so that a "U" is formed.
3. Put enough coolant into the hose to fill the center 127 mm (5 in.) of the U-shape.
4. Observe the U-shape while the engine is operating.
 - **During idle and warm-up:** Some coolant and air will leave the reservoir.
 - **At cruising speed (2500-3500 RPM):** Coolant and air leaving the reservoir should stop after approximately five minutes operating at a given RPM. A leaking head gasket will produce air bubbling through the U-shape, going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
 - **At higher speeds (4000+ RPM):** Normal operation is the same as described above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given RPM. A head gasket leak will not stop; the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Thermostat

Thermostat Housing—Exploded View



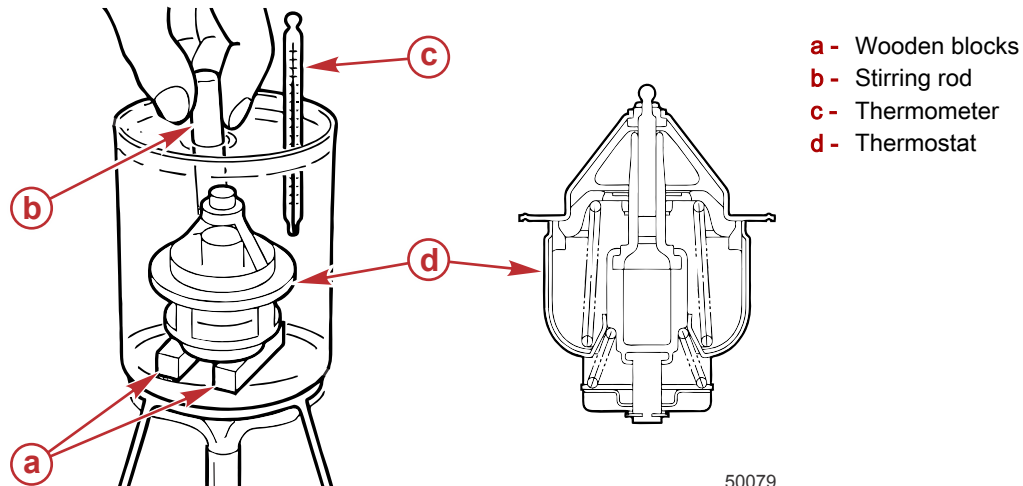
Thermostat Removal

Refer to the exploded view.

1. Drain the coolant from the engine.
2. Disconnect the hose from the thermostat housing cover.
3. Remove the thermostat housing cover bolts, the cover, and the seal.
4. Remove the thermostat from the thermostat housing.

Thermostat Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Add water to the container until it covers the thermostat.
4. Heat the water.
5. Stir the water constantly to avoid applying direct heat to the thermostat.



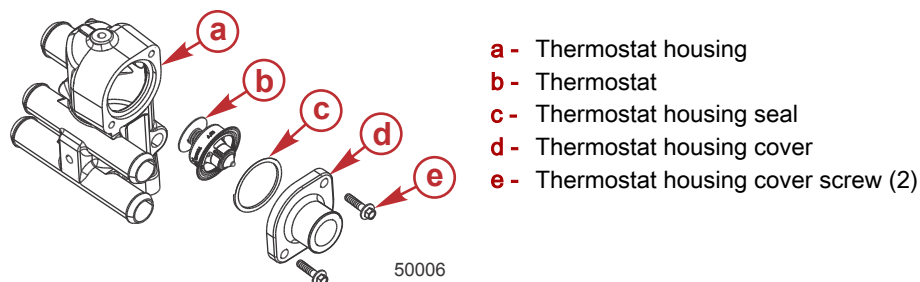
6. Observe the thermostat and check the temperature when the thermostat fully opens. If the temperature is not within specifications, then replace the thermostat.

Thermostat Installation

1. Remove the thermostat housing and the gaskets. Discard the gaskets.
2. Clean the gasket surfaces on the thermostat cover, the thermostat housing, and the intake manifold.
3. Position the gasket on the intake manifold. Place the thermostat housing on the gasket.
4. Tighten the screws to specification.

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake screw	33		24

5. Install the seal onto the thermostat flange.
6. Install the thermostat into the thermostat housing.
7. Install the thermostat cover. Tighten the screws to specification.



Description	Nm	lb-in.	lb-ft
Thermostat cover screw	30		22

8. Connect the hoses. Tighten the hose clamps securely.
9. Supply cooling water, start the engine, and inspect for leaks.

Changing Coolant

Closed-Cooling Section

The engine and exhaust sections of a closed-cooling system should remain filled year-round with the recommended coolant solution. Do not drain the closed-cooling section for storage, as this will promote rusting of internal surfaces. If the engine will be exposed to freezing temperatures, fill the closed-cooling section with Extended Life Coolant or an ethylene glycol antifreeze and water solution. Follow the manufacturer's recommended proportions to protect the engine to the lowest temperature to which it will be exposed. If necessary, change the coolant using the coolant specified in **Coolant Recommendations**.

Change Intervals

If the closed-cooling system is factory installed, drain and flush the coolant from the closed-cooling system at least every five years or 1000 hours of operation, whichever comes first. Change the coolant whenever exhaust gases have entered the system. If the system is not factory installed or has had anti-freeze other than Extended Life Coolant added, it must be changed every two years or 400 hours of operation, whichever comes first.

Draining

⚠ CAUTION

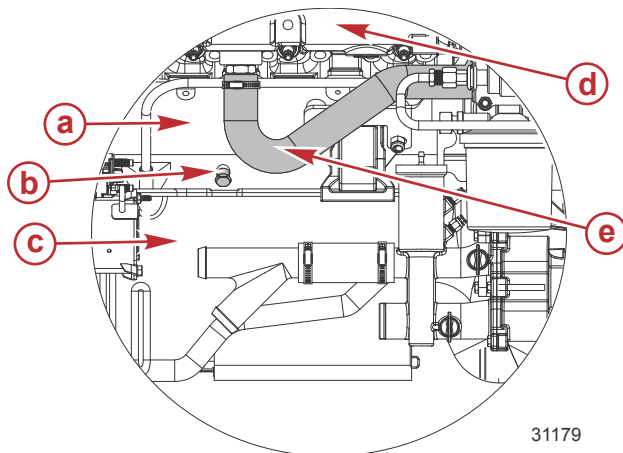
A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On some models with a two-piece petcock, removal of the petcock may be required so that wire can be inserted completely into the drain hole.

IMPORTANT: The engine must be as level as possible to ensure the complete draining of the cooling system.

IMPORTANT: The closed-cooling section must be kept filled year-round with recommended coolant. If the engine will be exposed to freezing temperatures, ensure that the closed-cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

1. Remove the pressure cap from the coolant tank.
2. On the port and starboard sides of the engine block, remove the block pipe plugs. Drain the coolant into a proper container.
3. On the port and starboard sides of the engine block, remove the coolant hoses from the bottom of the exhaust manifolds. Drain the coolant into a proper container.

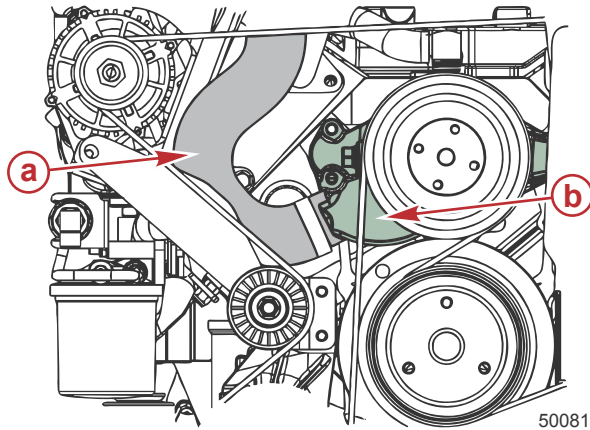


Port and starboard side similar

- a - Engine block
- b - Engine block drain plug
- c - Oil pan
- d - Exhaust manifold
- e - Exhaust manifold coolant hose

Models with Closed Cooling

4. Remove the hose from the heat exchanger to the water circulating pump at the pump connection. Drain the coolant into a proper container.



- a - Hose from heat exchanger to water circulating pump
- b - Water circulating pump

5. After the coolant has drained completely, reinstall the block pipe plug and hoses. Securely tighten the clamps.
6. Remove the coolant recovery bottle from the mounting bracket and drain the coolant into a proper container.

Cleaning the Cooling System

Closed-Cooling Section

Clean the closed-cooling section at least once every five years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale, or other foreign material. Always follow the manufacturer's instructions for the cleaner.

If the closed-cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits.

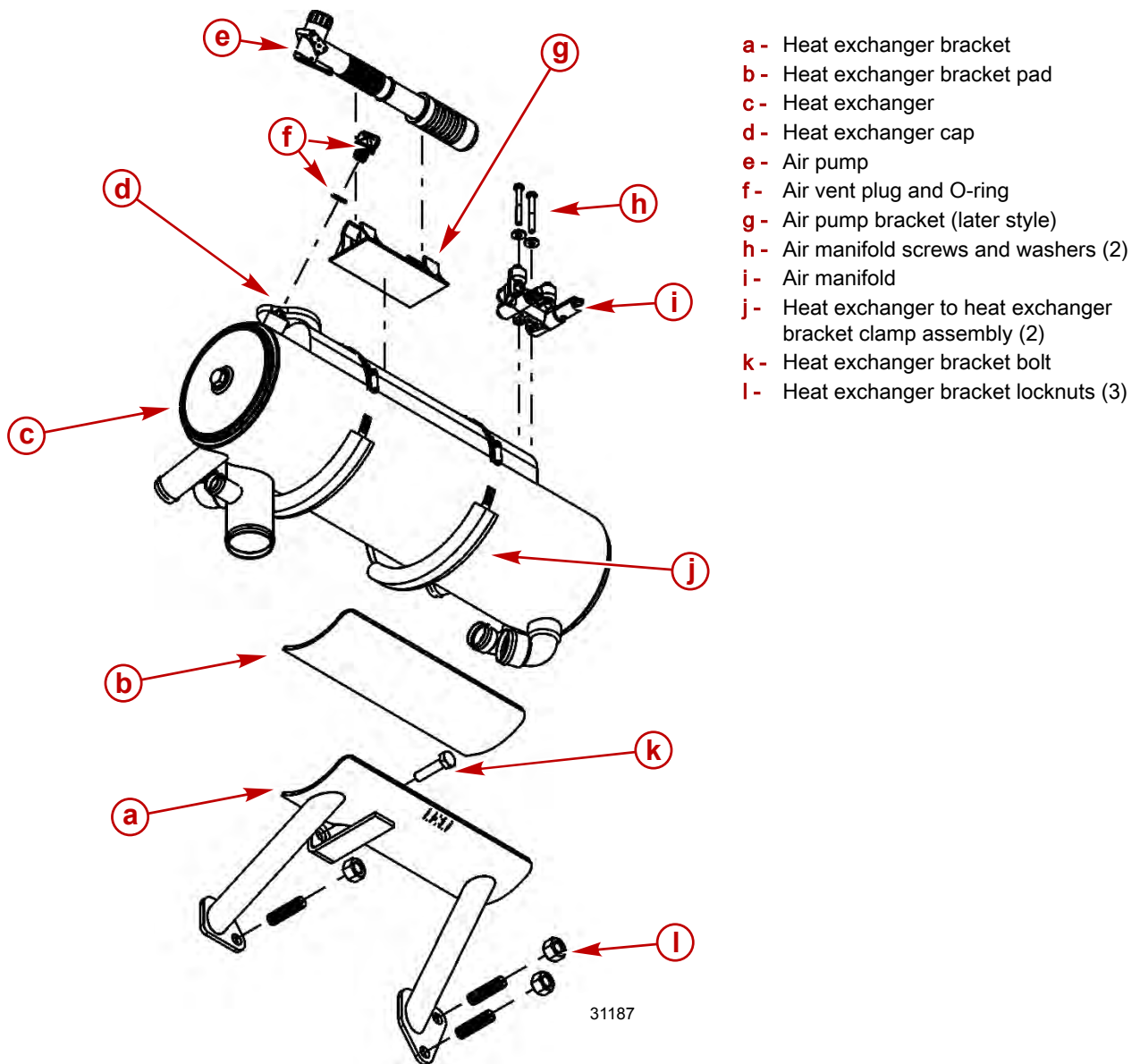
Flushing should be done in the opposite direction of the normal coolant flow to allow water to get behind deposits and force them out. Refer to the instructions that accompany the flushing device for the proper hookup and flushing procedure.

Seawater Section

The cooling efficiency of an engine with closed cooling is dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, or lime) collect on the inside of the tubes, reducing heat transfer and reducing the efficiency of the heat exchanger. It is recommended that the seawater section of the heat exchanger be cleaned as specified or whenever decreased cooling efficiency is suspected. Refer to **Heat Exchanger Assembly**.

Heat Exchanger Assembly

Heat Exchanger Assembly—Exploded View



Testing—Internal Leaks

An internal leak will allow coolant to enter into the seawater circuit when the closed-cooling circuit is pressurized.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed-cooling circuit to 110-138 kPa (16-20 psi) with a radiator tester.
3. If seawater begins to flow from the seawater hose fitting of the heat exchanger, there is a leak.

Blockage

IMPORTANT: Seawater flows through the tubes in the exchanger. Coolant/antifreeze flows around the tubes.

1. Remove the end caps and inspect for any blockage in the seawater circuit, such as broken impeller blades or weeds.
2. Remove the closed-cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

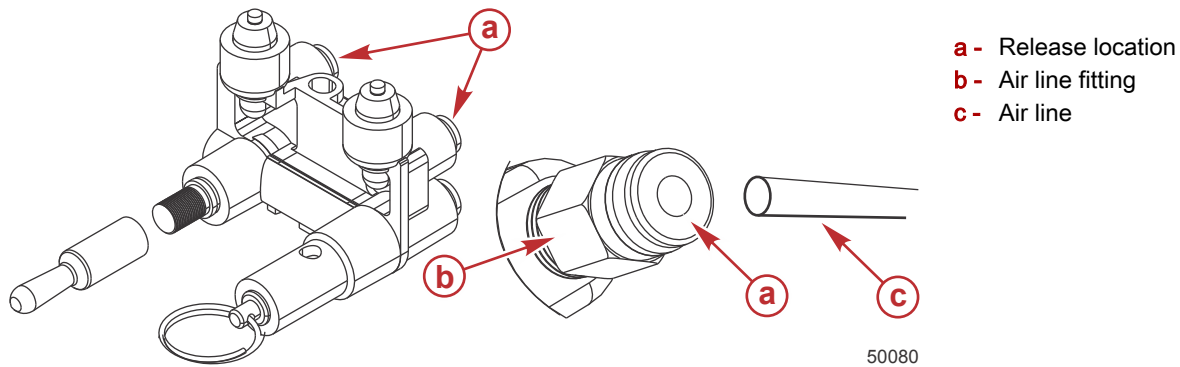
Removal

NOTE: The heat exchanger does not have to be removed for cleaning.

1. Allow the engine to cool.

Models with Closed Cooling

2. Drain the seawater from the engine.
3. Drain the coolant from the engine.
4. If applicable, remove each air line from the air manifold by pressing on the fitting and pulling the line out.

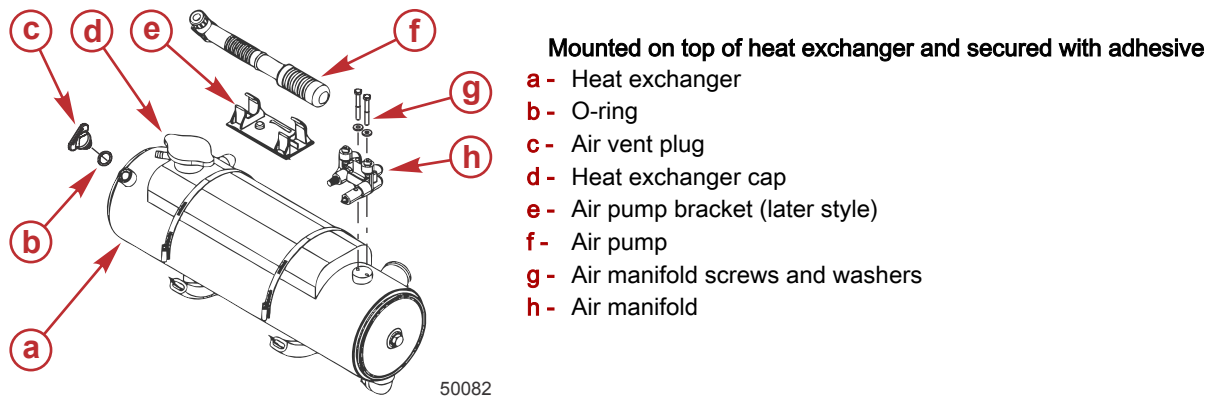


5. Remove the hoses from the heat exchanger.
6. Remove the two large hose clamps fastening the heat exchanger to the engine.
7. Remove the heat exchanger.

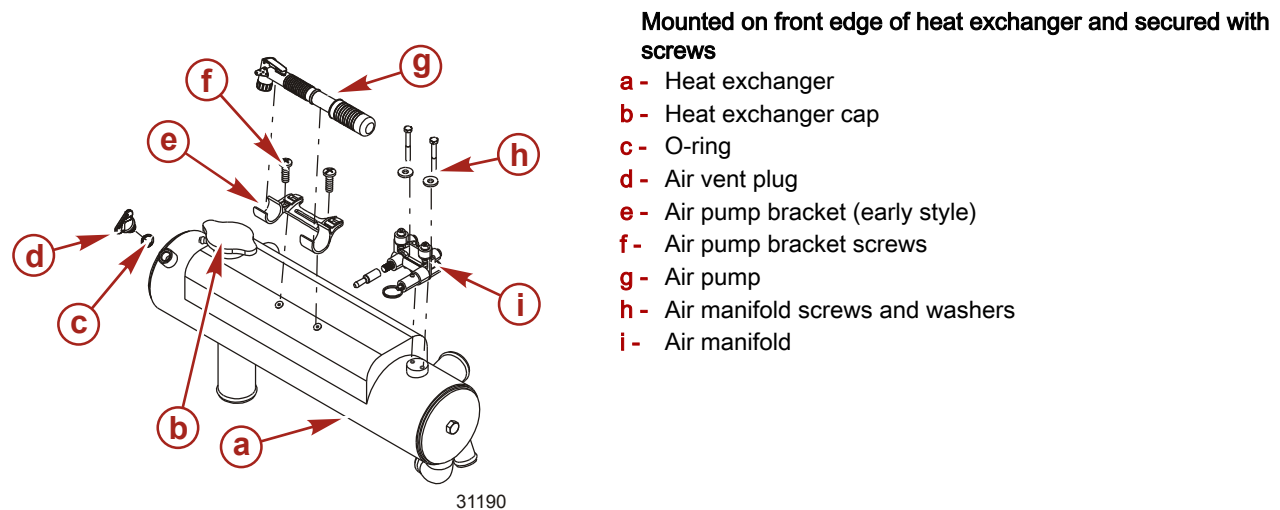
Disassembly

IMPORTANT: Do not remove the air pump and air pump bracket if they are mounted to the engine compartment.

1. Remove the air pump from the air pump bracket.
2. If the air pump bracket is secured with adhesive, do not remove the bracket.

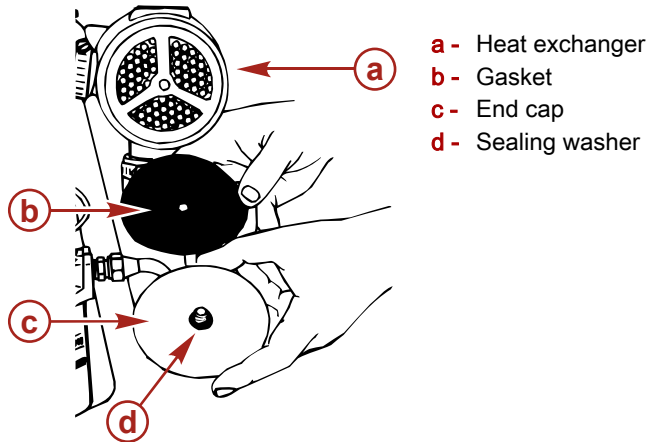


3. If the air pump bracket is secured by screws, remove the air pump bracket.



4. Remove the air manifold.

5. Remove the screws attaching the end cap to the heat exchanger.
6. Remove the end caps and gaskets.



6747

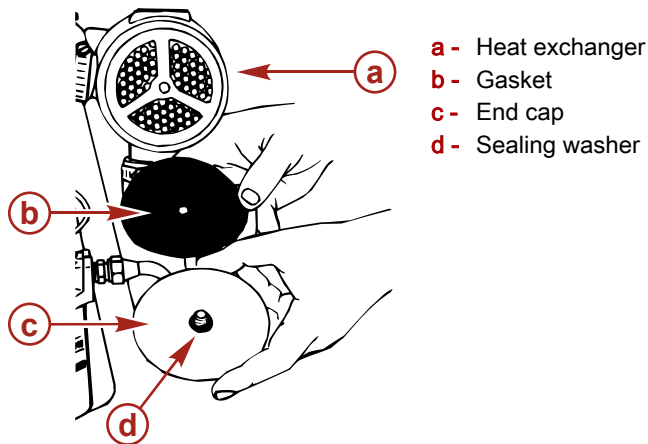
Cleaning and Inspection

1. Clean the old gasket material and sealant from the surfaces. Do not nick or gouge the surfaces.
2. Use a long rod and wire brush to clean out heat exchanger tubes.
3. Inspect each part for cracks or other damage. Replace as necessary.
4. Clean and paint the exterior surfaces as required to prevent corrosion.

Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Do not melt the other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in the cooling capacity. Do not close more than three tubes.
2. Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.



6747

Description	Nm	lb-in.	lb-ft
Heat exchanger end cap screw	6	54	

3. If applicable, fasten the air pump bracket to the heat exchanger. Tighten the screws securely.
4. Fasten the air manifold to the heat exchanger. Tighten the screws to specification.

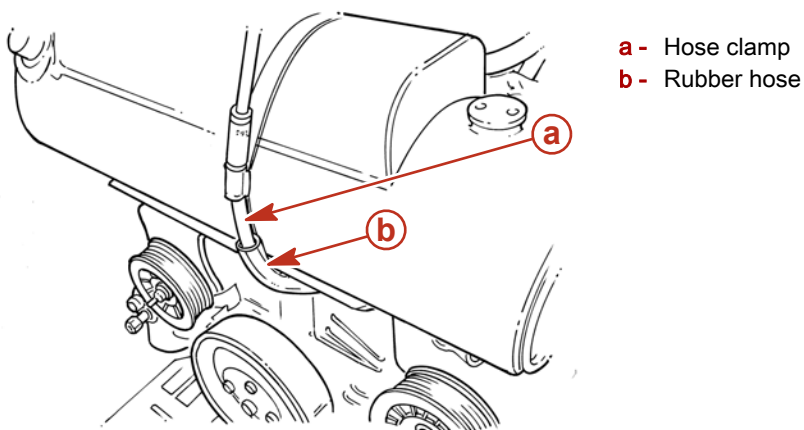
Description	Nm	lb-in.	lb-ft
Air manifold screws	3	27	

Installation

1. Lower the heat exchanger onto the bracket and simultaneously attach the water hoses.
2. Ensure that all hose ends are aligned and fully seated on the heat exchanger fittings. Tighten all hose clamps securely.

Models with Closed Cooling

3. Install the large hose clamps around the heat exchanger bracket and heat exchanger. Position the rubber hoses underneath the bracket to prevent the bracket from directly contacting the hose clamps and breaking them.

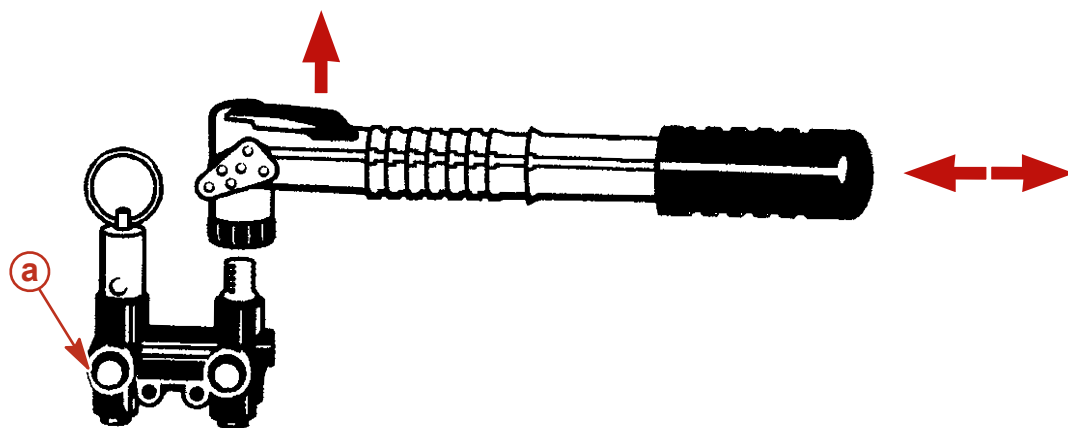


13065

4. Tighten the hose clamps to specification.

Description	Nm	lb-in.	lb-ft
Hose clamps around heat exchanger and bracket	3	26	

5. Connect the air lines to the air manifold by inserting the line into the fitting until a positive stop is encountered.
6. Ensure that the air lines are installed properly.
 - a. Attach the air pump to the fitting on the air manifold.



8223

- a - Green indicators**

- b. Pull up on the air pump lever (vertical) to lock the pump onto the fitting.
 - c. Pump air into the system until both green indicators extend. If the green indicators do not extend, the air lines are not attached properly.
7. Fill the closed-cooling system with the specified coolant.

Cooling System

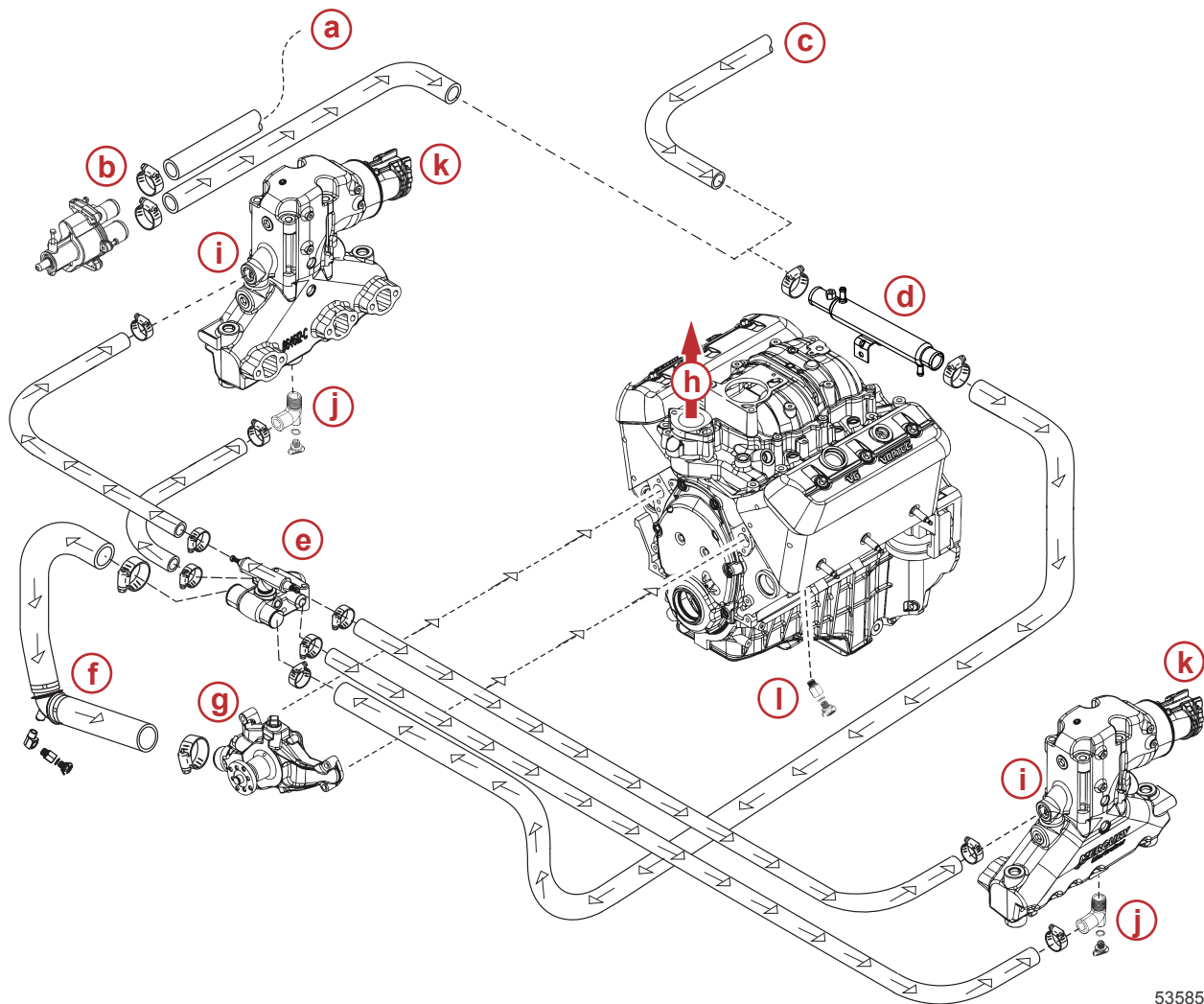
Section 6D - Water Flow Diagrams

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4.3L TKS

TKS Seawater Cooling

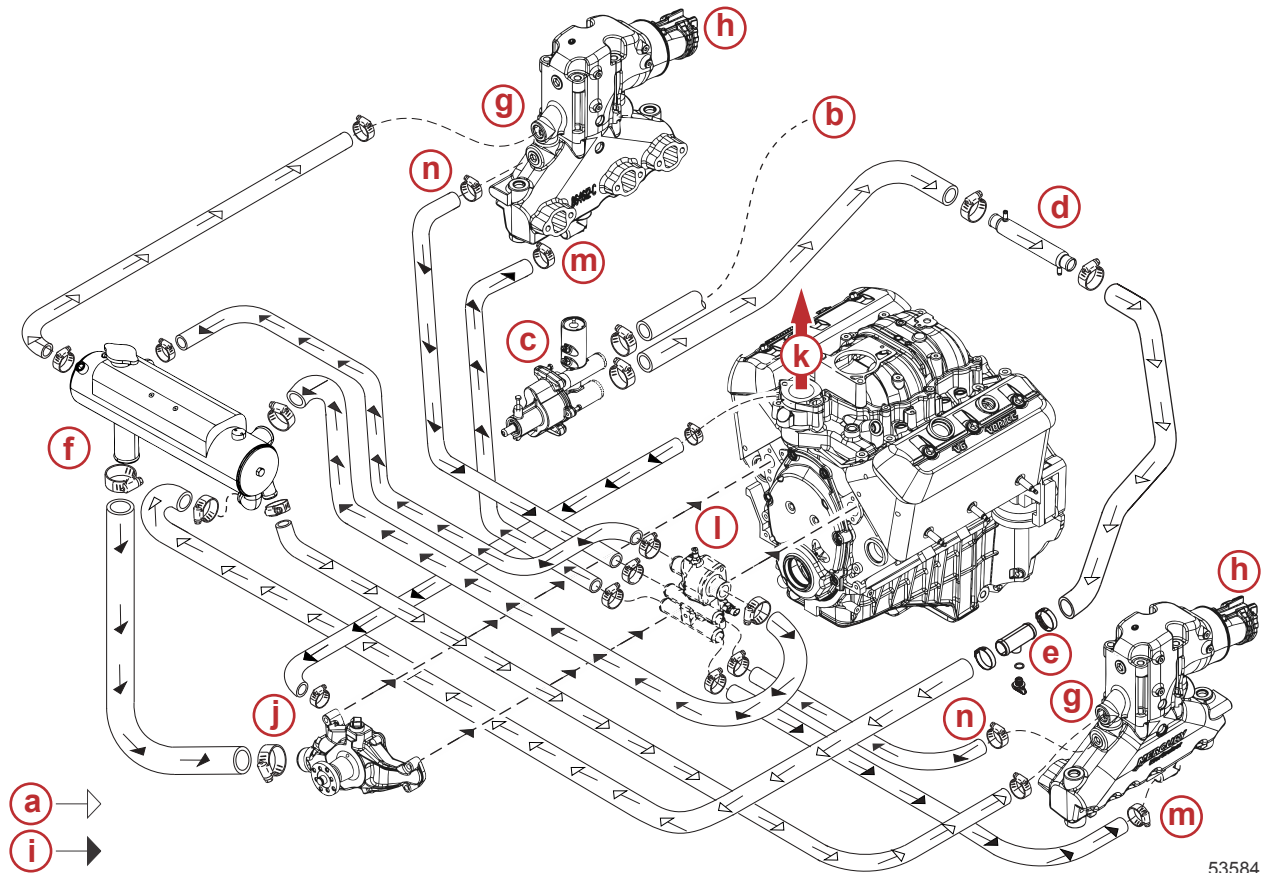


53585

Carbureted models with dry-joint exhaust, seawater cooling, and multi-point drain

- a** - Seawater inlet (Bravo drive)
- b** - Seawater pump (Bravo only)
- c** - Seawater inlet (Alpha drive)
- d** - Power steering fluid cooler
- e** - Thermostat housing
- f** - Drain elbow
- g** - Water circulating pump
- h** - To thermostat housing
- i** - Exhaust elbow seawater inlet
- j** - Exhaust manifold seawater inlet and drain
- k** - Exhaust and seawater outlet
- l** - Drain fitting assembly

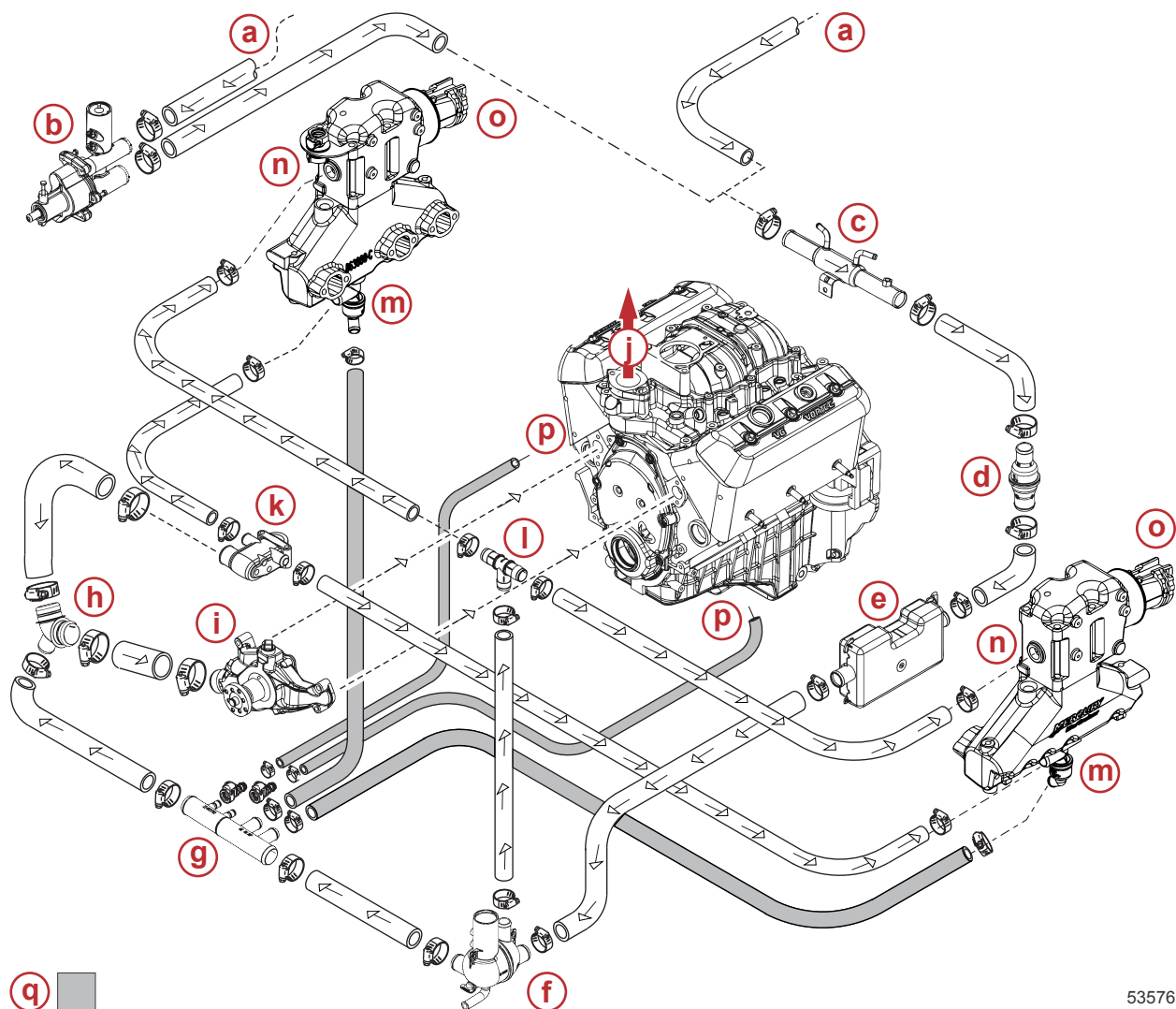
TKS Closed Cooling

**Carbureted models with dry-joint exhaust and closed cooling**

- a** - Seawater flow
- b** - Seawater inlet
- c** - Seawater pump
- d** - Power steering fluid cooler
- e** - Drain T-fitting
- f** - Heat exchanger
- g** - Exhaust elbow seawater inlet
- h** - Exhaust and seawater outlet
- i** - Glycol coolant flow
- j** - Water circulating pump
- k** - To thermostat housing
- l** - Thermostat housing
- m** - Exhaust manifold coolant inlet
- n** - Exhaust manifold or riser coolant outlet

4.3L MPI

MPI Seawater Cooling (Easy Drain)

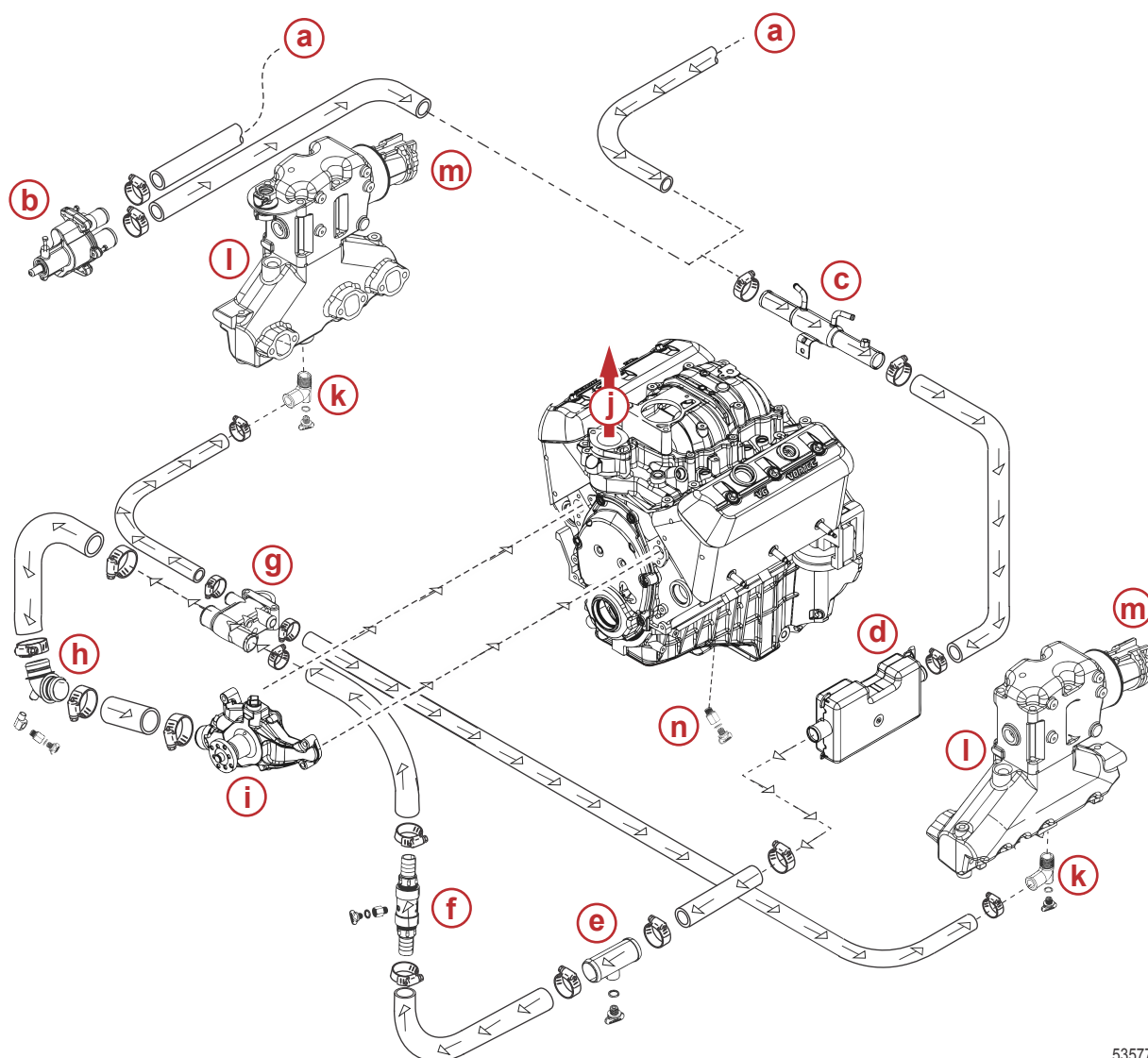


53576

MPI models with wet-joint exhaust, seawater cooling, and Easy Drain

- a** - Seawater inlet
- b** - Seawater pump (Bravo only)
- c** - Power steering fluid cooler
- d** - Check valve assembly
- e** - Gen II Cool Fuel module
- f** - Distribution housing
- g** - Distribution fittings
- h** - Y-fitting
- i** - Water circulating pump
- j** - To thermostat housing
- k** - Thermostat housing
- l** - T-fitting
- m** - Exhaust manifold seawater inlet and drain
- n** - Exhaust elbow seawater inlet
- o** - Exhaust and seawater outlet
- p** - Engine block drain
- q** - Exhaust manifold and engine block drain hoses

MPI Seawater Cooling (Multipoint Drain)

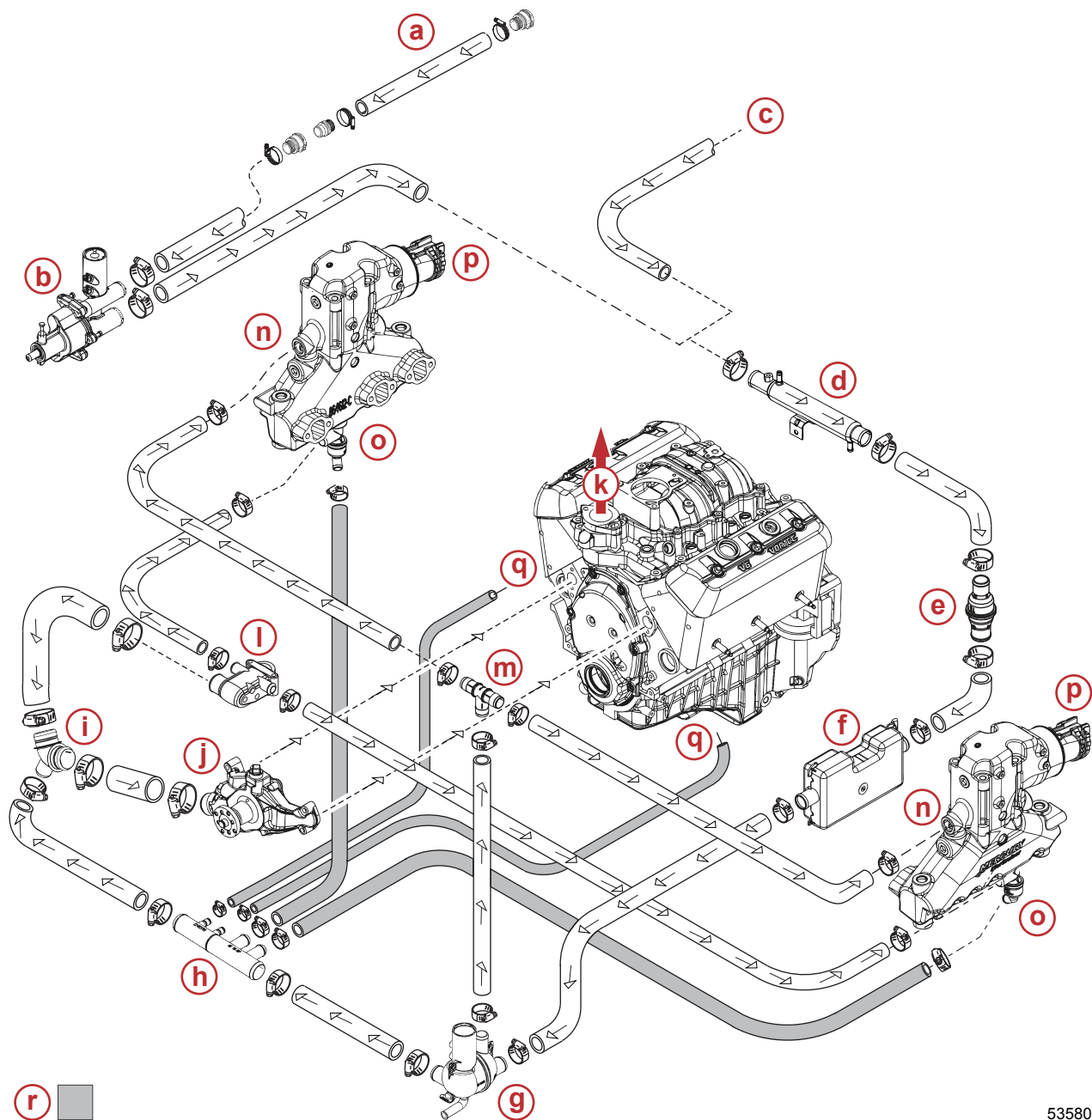


53577

MPI models with wet-joint exhaust, seawater cooling, and multipoint drain

- a** - Seawater inlet
- b** - Seawater pump (Bravo only)
- c** - Power steering fluid cooler
- d** - Gen II Cool Fuel module
- e** - Drain T-fitting
- f** - Check valve with drain
- g** - Thermostat housing
- h** - Drain elbow
- i** - Water circulating pump
- j** - To thermostat housing
- k** - Exhaust manifold seawater inlet and drain
- l** - Exhaust elbow
- m** - Exhaust and seawater outlet
- n** - Drain fitting assembly

MPI Seawater Cooling (Single and 3-Point Drain)

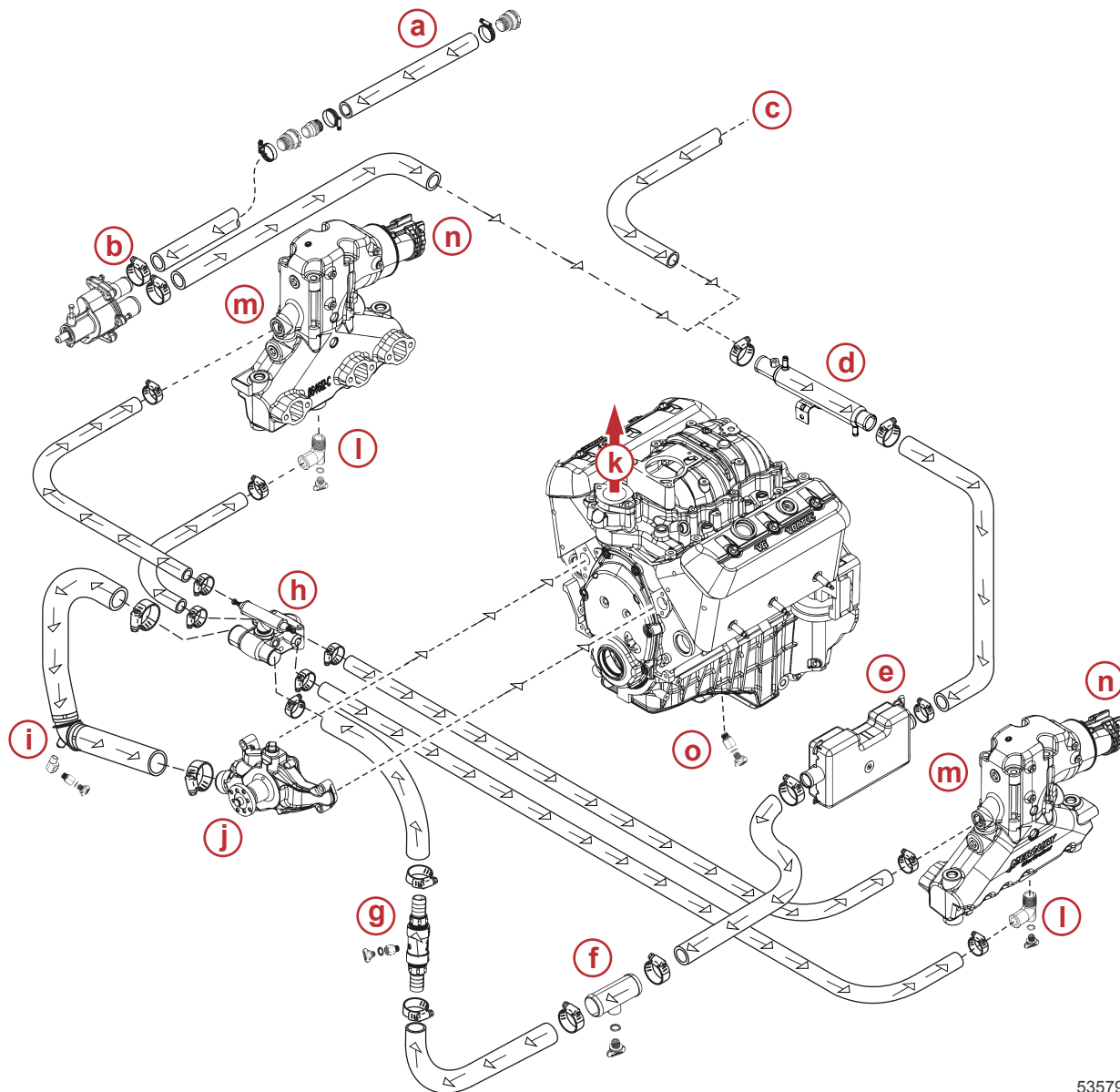


53580

MPI models with dry-joint exhaust, seawater cooling, and single-point drain (Alpha) or 3-point drain (Bravo)

- a** - Seawater inlet quick disconnect hose (Bravo drive)
- b** - Seawater pump (Bravo only)
- c** - Seawater inlet (Alpha drive)
- d** - Power steering fluid cooler
- e** - Check valve assembly
- f** - Gen II Cool Fuel module
- g** - Distribution housing
- h** - Distribution fittings
- i** - Y-fitting
- j** - Water circulating pump
- k** - To thermostat housing
- l** - Thermostat housing
- m** - T-fitting
- n** - Exhaust elbow seawater inlet
- o** - Exhaust manifold seawater inlet and drain
- p** - Exhaust and seawater outlet
- q** - Engine block drain
- r** - Exhaust manifold and engine block drain hoses

MPI Seawater Cooling (7-Point Drain)

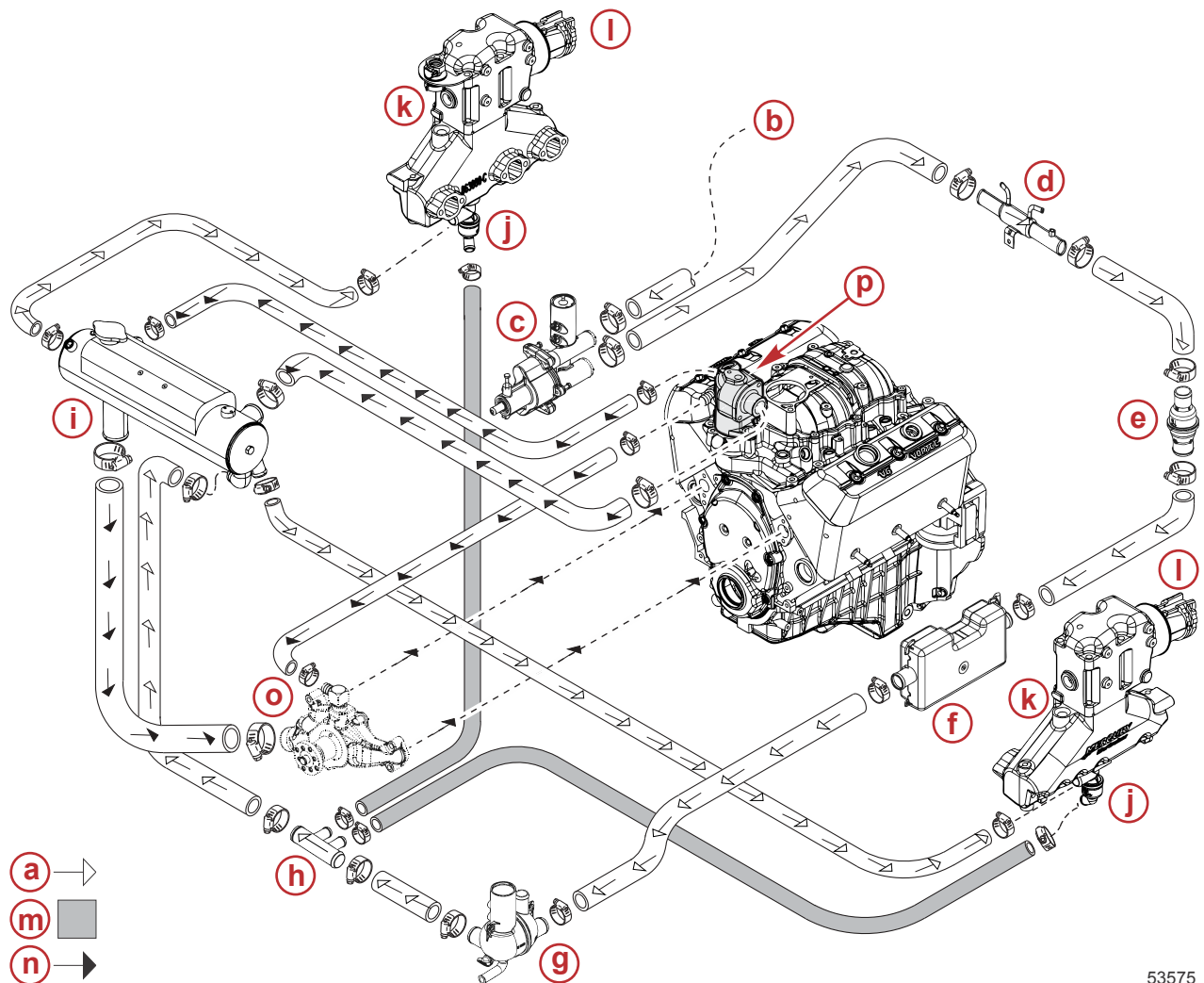


53579

MPI models with dry-joint exhaust, seawater cooling, and 7-point drain

- a** - Seawater inlet quick connect hose (Bravo drive)
- b** - Seawater pump (Bravo only)
- c** - Seawater inlet (Alpha drive)
- d** - Power steering fluid cooler
- e** - Gen II Cool Fuel module
- f** - Drain T-fitting
- g** - Check valve with drain
- h** - Thermostat housing
- i** - Drain elbow
- j** - Water circulating pump
- k** - To thermostat housing
- l** - Exhaust manifold seawater inlet and drain
- m** - Exhaust elbow seawater inlet
- n** - Exhaust and seawater outlet
- o** - Drain fitting assembly

MPI Closed Cooling (Easy Drain)

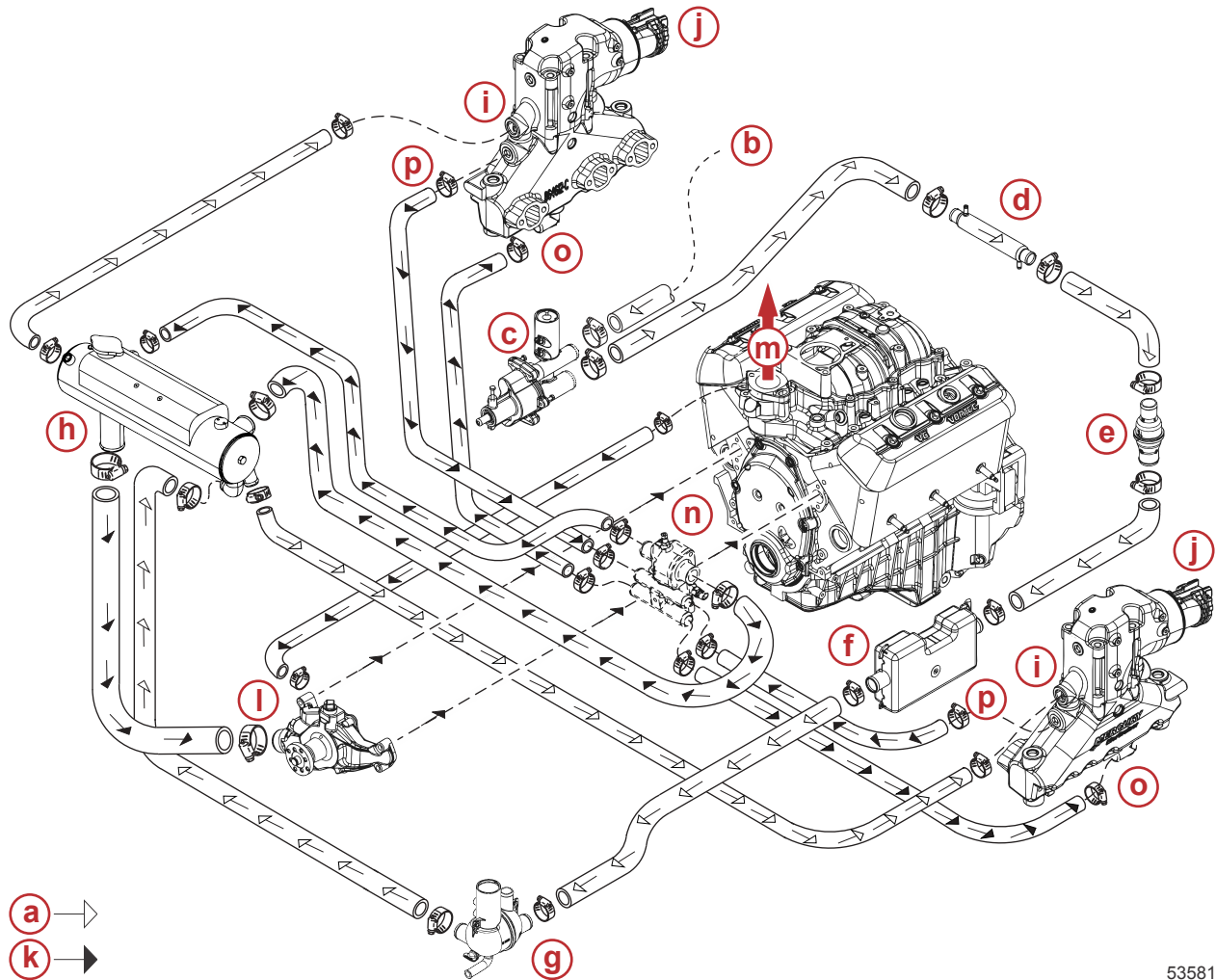


53575

MPI models with wet-joint exhaust, closed cooling, and Easy Drain

- a** - Seawater flow
- b** - Seawater inlet
- c** - Seawater pump
- d** - Power steering fluid cooler
- e** - Check valve assembly
- f** - Gen II Cool Fuel module
- g** - Distribution housing
- h** - Distribution fitting
- i** - Heat exchanger
- j** - Exhaust manifold seawater inlet and drain
- k** - Exhaust elbow
- l** - Exhaust and seawater outlet
- m** - Exhaust manifold drain hoses
- n** - Glycol coolant flow
- o** - Water circulating pump
- p** - Thermostat housing

MPI Closed Cooling (Air-Actuated Drain)



53581

MPI models with dry-joint exhaust, closed cooling, and air-actuated drain

- a** - Seawater flow
- b** - Seawater inlet
- c** - Seawater pump
- d** - Power steering fluid cooler
- e** - Check valve assembly
- f** - Gen II Cool Fuel module
- g** - Distribution housing
- h** - Heat exchanger
- i** - Exhaust elbow seawater inlet
- j** - Exhaust and seawater outlet
- k** - Glycol coolant flow
- l** - Water circulating pump
- m** - To thermostat housing
- n** - Thermostat housing
- o** - Exhaust manifold coolant inlet
- p** - Exhaust manifold or riser coolant outlet

Exhaust System

Section 7A - Important Information

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Exhaust System Notice

NOTICE

Improperly designing, installing, or modifying the engine's exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boatbuilder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boatbuilder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Measuring Engine Exhaust Elbow Height

General Information

The height of the exhaust elbows must be within the dimensions specified to prevent water intrusion. If needed, install exhaust elbow risers to obtain sufficient exhaust elbow height and exhaust angle. Take measurements with the boat in the water. To simulate maximum loading conditions likely to be encountered, refer to **Loading Requirements**.

IMPORTANT: If installing a water lift muffler, measure the elbow height to the waterline inside the water lift muffler, not to the waterline outside of the boat. Refer to Clear Hose Measurement Method from a Seacock or Muffler Drain.

IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boatbuilders must communicate any load distribution conditions that affect the exhaust system, such as maximum occupancy of the swim platform, to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Minimum Exhaust Elbow Height

Model	Specification
4.3 MPI and TKS models	33 cm (13 in.)

Minimum Exhaust Hose Slope

Model	Specification	
	Within 46 cm (18 in.) of engine	Remainder of system (if applicable)
All models	10°	3°

If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to Mercury Precision Parts' **Accessories Guide** for part numbers.

Available Risers

Model	Serial No. Range	Low	Medium	High
4.3 TKS	0W300013–0W309999	NA	76 mm (3.0 in.)	NA
	0W310000 and above	43 mm (1.7 in.)	76 mm (3.0 in.) 119 mm (4.7 in.)	152 mm (6.0 in.)
4.3 MPI (wet joint)	0M000000–0M614999	NA	76 mm (3.0 in.)	152 mm (6.0 in.)
4.3 MPI	0W615000–0W309999	NA	76 mm (3.0 in.)	NA
	0W310000 and above	43 mm (1.7 in.)	76 mm (3.0 in.) 119 mm (4.7 in.)	152 mm (6.0 in.)

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.

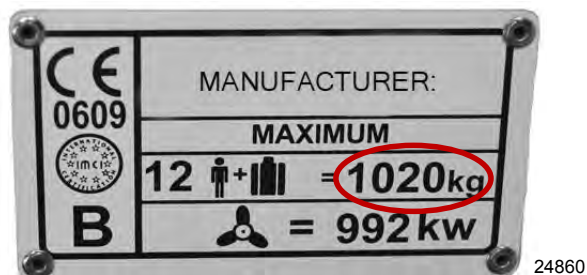
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
 - 1 U.S. gallon of water = 8.3 lb
 - 1 liter of water = 1 kg
 - 1 U.S. gallon of gasoline = 6 lb
 - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
 - One person is equivalent to 74.84 kg (165 lb)
 - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
 - a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
 - b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity, must add 181.45 kg (400 lb) to the swim platform.
 - c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
 - d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity, must add 226.80 kg (500 lb) to the swim platform.

Loading the Boat (Boats with a Capacity Plate)

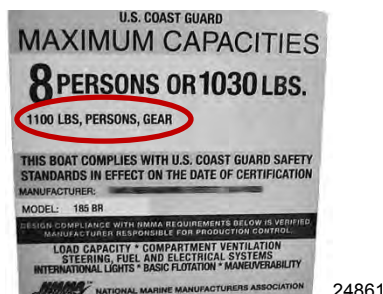
For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 in. for an average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
 - 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.
1. Take the maximum capacity weight as listed on the capacity plate (XXXX lbs, persons, gear) and subtract the swim platform load, if applicable.
 2. Next divide the weight by 74.84 kg (165 lb) per person. This gives the whole number and remainder of 74.84 kg (165 lb) persons to load onto the boat.
 3. Put the remainder of a person in the next available seat. See the boat loading diagram.



CE capacity plate



USCG capacity plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	Center storage	Bow storage
25%	50%	25%

Optional Cargo Distribution		
Aft storage	Center storage	Bow storage
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is loaded into each seat in that row.
9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.

NOTE: The following example is provided as a reference.

Example

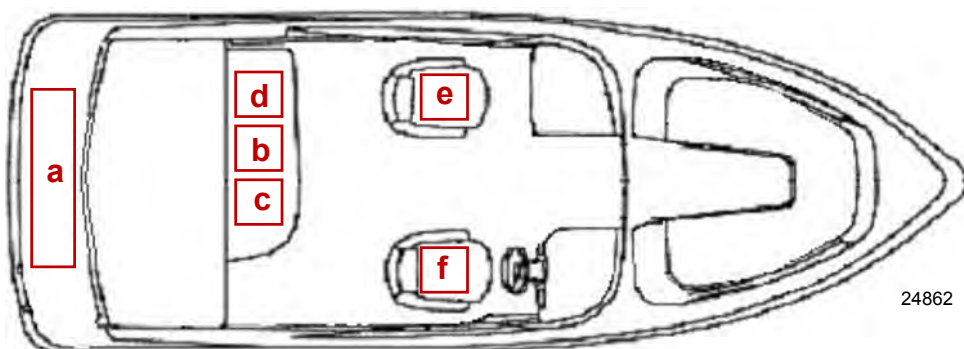
NOTE: This example uses a boat that is less than 8.84 m (29 ft) long, not including a boat that is 8.84 m (29 ft) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 kg (400 lb) to the swim platform.

NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
 - $1100 \text{ lb} - 400 \text{ lb} = 700 \text{ lb}$
2. Remaining weight to be placed in the boat $\div$ MerCruiser person weight = number of persons to load onto the boat.
 - $700 \text{ lb} \div 165 \text{ lb} = 4.24 \text{ persons}$
3. Total number of persons – number of whole persons = remaining persons.
 - $4.24 \text{ persons} - 4 \text{ persons} = 0.24 \text{ remaining persons}$
4. Remainder persons $\div$ MerCruiser person weight = remainder MerCruiser person weight.
 - $0.24 \times 165 \text{ lb} = 40 \text{ lb}$

IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
5. Using the totals in this example, load four 165-lb persons and one 40-lb person onto boat seating with 400 lb on the swim platform.
 - $400 \text{ lb} + 165 \text{ lb} = 565 \text{ lb}$
 - $565 \text{ lb} + 165 \text{ lb} = 730 \text{ lb}$
 - $730 \text{ lb} + 165 \text{ lb} = 895 \text{ lb}$
 - $895 \text{ lb} + 165 \text{ lb} = 1060 \text{ lb}$

- 1060 lb + 40 lb = 1100 lb



Boat loading diagram

- a** - Swim platform load
- b** - MerCruiser person weight (one)
- c** - MerCruiser person weight (two)
- d** - MerCruiser person weight (three)
- e** - MerCruiser person weight (four)
- f** - Remainder MerCruiser person weight (five)

Loading the Boat (Boats without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 in. for an average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
 - 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.
1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
 - Number of persons × 165 lb (MerCruiser person weight) = XXXX lb maximum passenger load.
 2. Maximum passenger load from the calculation above – swim platform load if applicable.
 3. Divide the weight by 165 lb per person. This gives the number of 165-lb persons to load onto the boat. Round up to next whole number. See **Example 3**.

IMPORTANT: To account for cargo, add a weight of 25 lb per person to the boat before loading passenger weight onto the boat.

4. Calculate the cargo by multiplying 25 lb by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
 5. Load the cargo onto the boat. Distribute cargo as described below.
- IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.**

Preferred Cargo Distribution		
Aft storage	Center storage	Bow storage
25%	50%	25%

Optional Cargo Distribution		
Aft storage	Center storage	Bow storage
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

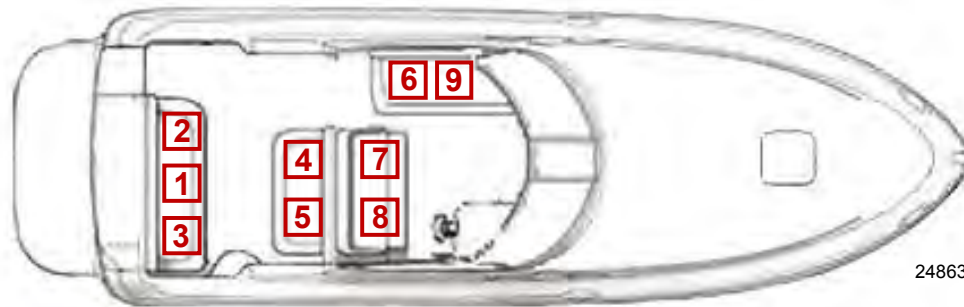
6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: The following example is provided as a reference.

This example uses a boat that is 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 kg (500 lb) to the swim platform.

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



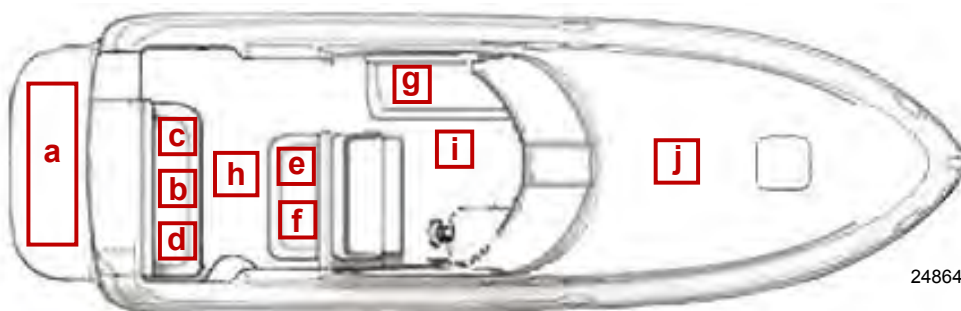
Designated seating diagram

This example uses nine persons as the maximum passenger load.

NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
 - 9 passengers × 25 lb = 225 lb
2. To determine the preferred cargo distribution for aft, center, and bow storage:
 - a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%.
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%.
 - a. 225 lb × 50% = 112.50 lb
 - b. 112.50 lb rounded up = 113 lb
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%.
 - 225 lb × 25% = 56.25 lb
 - 56.25 lb rounded down = 56 lb
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb (MerCruiser person weight) to get a 1485 lb (total passenger load).
 - 9 passengers × 165 lb = 1485 lb
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
 - 1485 lb – 500 lb = 985 lb

7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
 - $985 \text{ lb} \div 165 \text{ lb} = 5.9$ passengers
 - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb cargo in the aft storage, 113 lb cargo in the center storage, and 56 lb cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb passengers, onto the boat with 500 lb on the swim platform.
 - $500 \text{ lb} + 225 \text{ lb} = 725 \text{ lb}$
 - $725 \text{ lb} + 165 \text{ lb} = 890 \text{ lb}$
 - $890 \text{ lb} + 165 \text{ lb} = 1055 \text{ lb}$
 - $1055 \text{ lb} + 165 \text{ lb} = 1220 \text{ lb}$
 - $1220 \text{ lb} + 165 \text{ lb} = 1385 \text{ lb}$
 - $1385 \text{ lb} + 165 \text{ lb} = 1550 \text{ lb}$
 - $1550 \text{ lb} + 165 \text{ lb} = 1715 \text{ lb}$

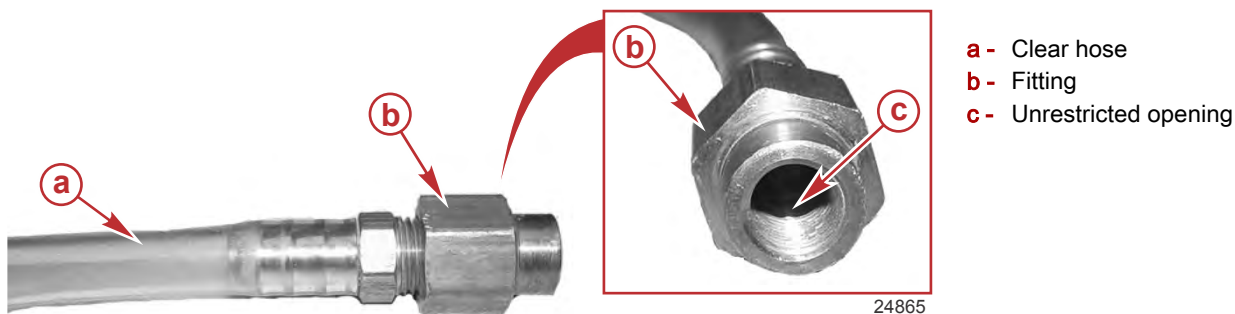


Cargo, swim platform, and passenger weight loading diagram

- a** - Swim platform load
- b** - MerCruiser person weight (one)
- c** - MerCruiser person weight (two)
- d** - MerCruiser person weight (three)
- e** - MerCruiser person weight (four)
- f** - MerCruiser person weight (five)
- g** - MerCruiser person weight (six)
- h** - Aft storage
- i** - Center storage
- j** - Bow storage

Clear Hose Measurement Method

1. Obtain an 8–10 mm (5/16–3/8 in.) I.D. clear hose, approximately 4.5 m (15 ft) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.

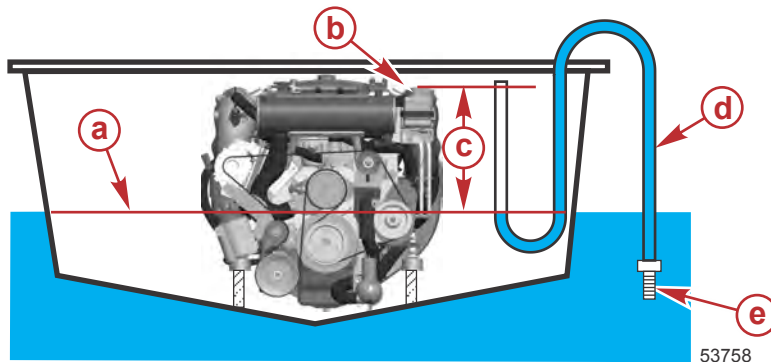


IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow to waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat that is sitting lower in the water.
3. Submerge the clear hose until it is completely filled with water.

Important Information

4. Place a finger over the open end of the clear hose before removing the hose from the water.
5. Coil the excess clear hose into the boat bilge. Keep the coil of hose below the waterline.
6. Keeping the hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust elbow.
7. Slowly take your finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



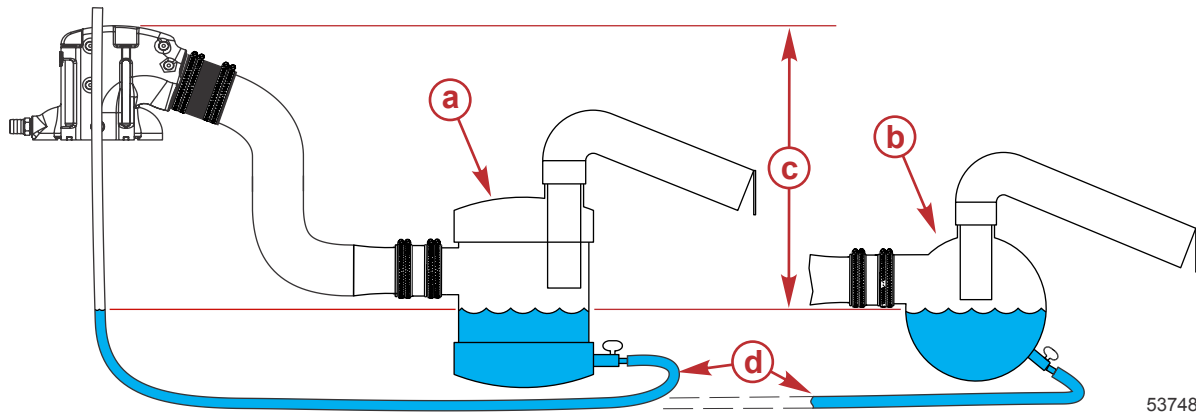
- a - Waterline
- b - Top of exhaust elbow
- c - Waterline to top of exhaust elbow measurement
- d - Clear hose
- e - Weight

Clear Hose Measurement from a Seacock or Muffler Drain

IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the waterline outside of the boat) on applications so equipped. The engine must have been operated to fill the muffler with water.

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. Open the valve for the drain point to which the clear hose is attached.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that the open-end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil any excess hose in the bilge of the boat, keeping it below the waterline.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift the open end until it is even with the top of the exhaust elbow.
7. Slowly take your finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water in the muffler. Keep the hose close to the exhaust elbow and as vertical as possible.
8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height.



- a - Vertical water lift muffler
- b - Horizontal water lift muffler
- c - Minimum exhaust elbow height with maximum load
- d - Clear hose for measuring waterline

IMPORTANT: Horizontal water lift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline. Refer to the appropriate applications manual for details.

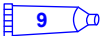
Exhaust System

Section 7B - Manifolds, Elbows, and Risers for Wet Joint

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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Exhaust manifold and elbow plug threads	92-809822

General Information

Seawater Cooled Models

The term seawater cooled, also known as raw water cooled (RWC), refers to the use of water, such as seawater, for cooling throughout the system, in the engine cooling passages, and in the exhaust water jackets. This water source is picked up through the sterndrive and engine seawater pump.

Wet Joint

Wet joint is a description based on the style of exhaust system on these engines. The wet-joint exhaust system confines both the engine seawater and exhaust gases with the same gasket sealing surface at the exhaust manifold to elbow joint (wet joint). In the exhaust elbow, the engine seawater and exhaust gases mix and discharge together. This system was used on engines produced prior to 2002.

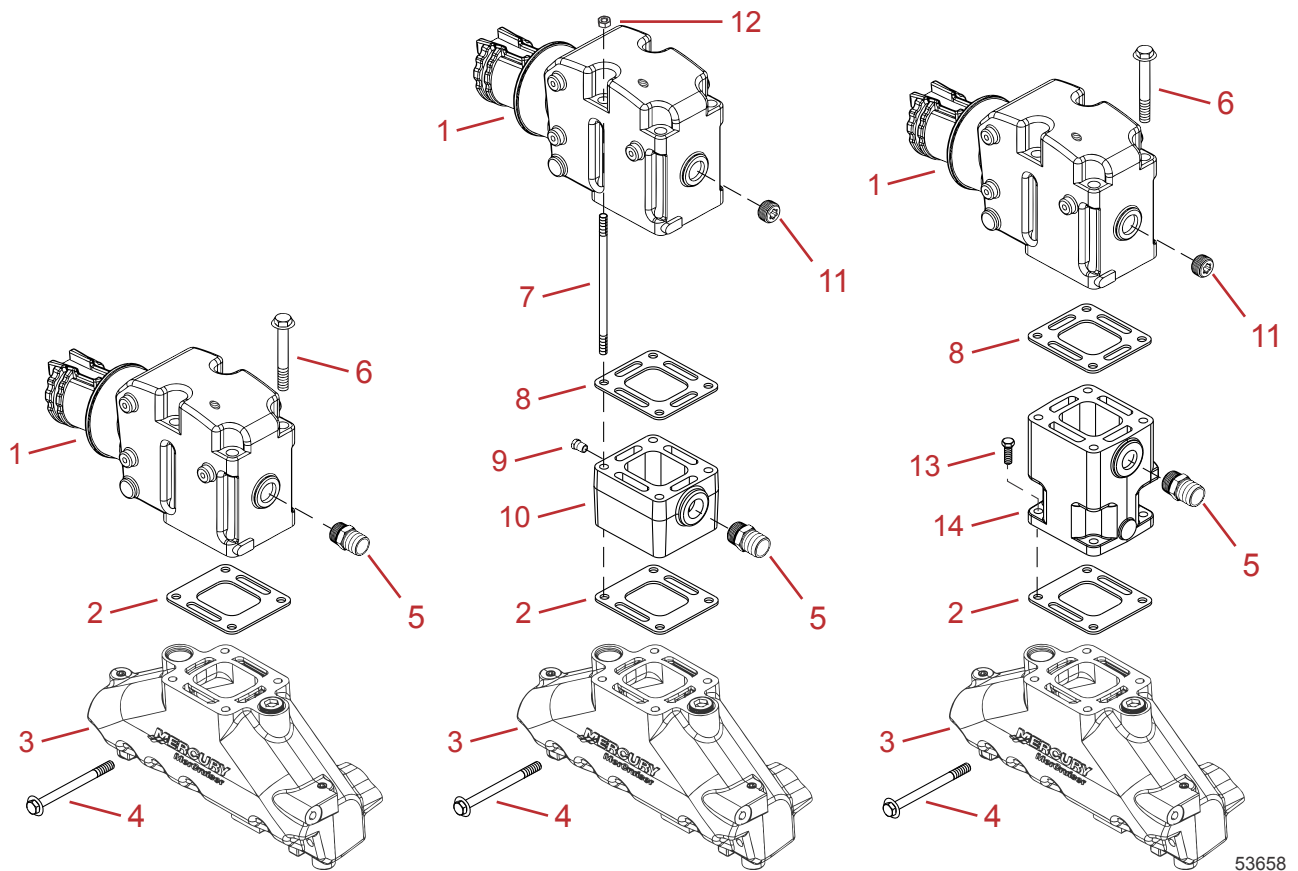
Half Loop Closed Cooling Systems

Half loop closed cooling systems use an ethylene glycol mixture to cool the engine block. The hot glycol mixture is circulated through the heat exchanger tubes and engine block water jackets. Heat transfer occurs when cool raw water from the sea pump flows through the heat exchanger and is discharged into the exhaust stream at the exhaust elbows.

NOTE: Refer to **Section 6D - Water Flow Diagrams** for full loop and half loop cooling system flow diagrams.

Exploded View

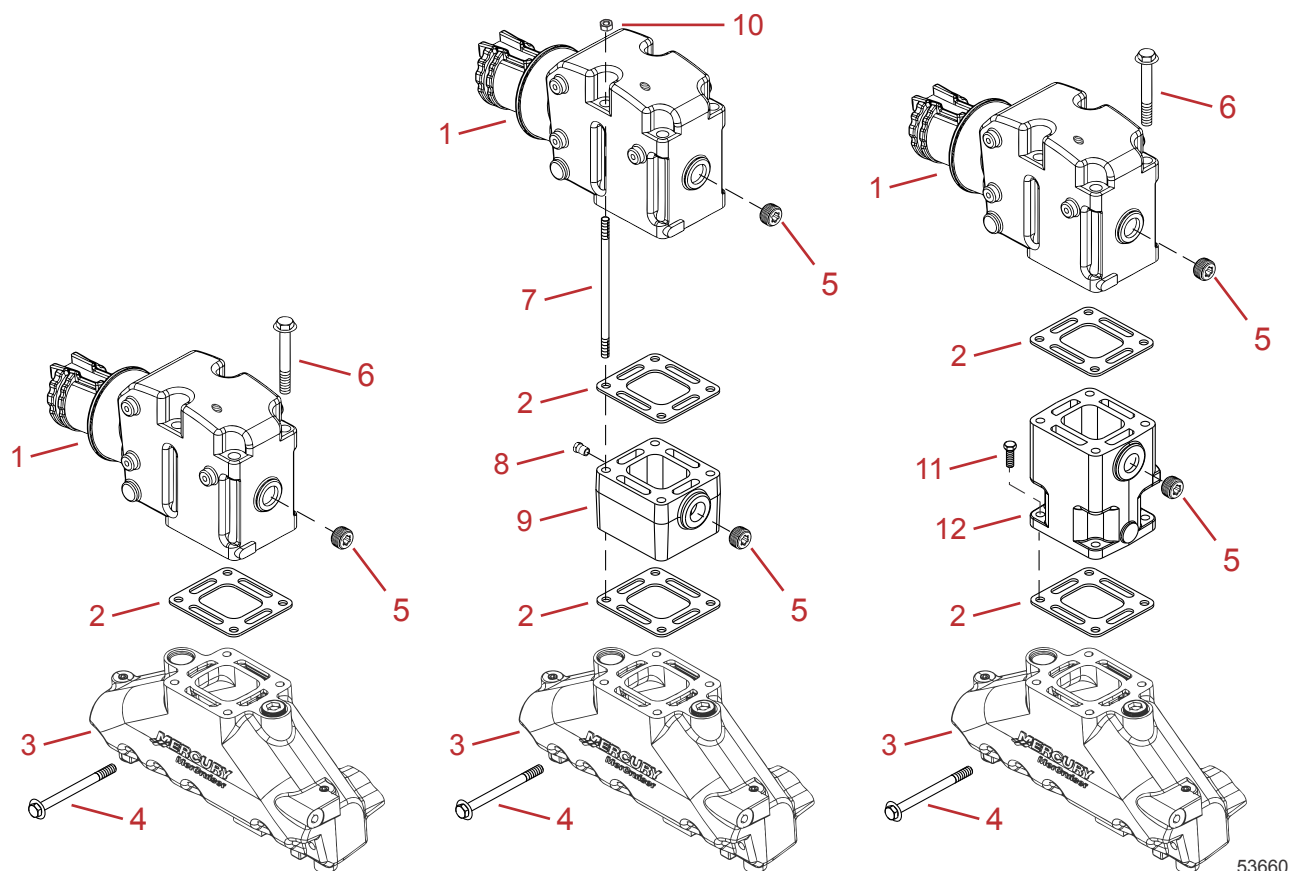
Models with Seawater Cooling and Easy Drain—Exploded View



53658

- 1 - Exhaust elbow assembly
- 2 - Restrictor gasket
- 3 - Exhaust manifold assembly
- 4 - Screw
- 5 - Fitting
- 6 - Screw
- 7 - Stud
- 8 - Open gasket
- 9 - Pipe plug
- 10 - 76 mm (3.0 in.) exhaust riser
- 11 - Pipe plug
- 12 - Flange nut
- 13 - Screw
- 14 - 152 mm (6.0 in.) exhaust riser

Models with Seawater Cooling and Multipoint Drain and Models with Closed Cooling— Exploded View



53660

- 1 - Exhaust elbow assembly
- 2 - Open gasket
- 3 - Exhaust manifold assembly
- 4 - Screw
- 5 - Pipe plug
- 6 - Screw
- 7 - Stud
- 8 - Pipe plug
- 9 - 76 mm (3.0 in.) exhaust riser
- 10 - Flange nut
- 11 - Screw
- 12 - 152 mm (6.0 in.) exhaust riser

Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect both battery cables from the battery.
2. Drain the seawater section of the engine. Refer to **Section 1C - Maintenance**.
3. Disconnect the exhaust hoses and the cooling hoses from the exhaust manifold and elbow.
4. Remove the shift plate.
5. Remove the ECM and the ECM bracket.

6. Remove any other components that are mounted to the manifold, the elbow, or the riser.
7. Remove the elbow and the riser.
8. Remove the exhaust manifold and discard the gaskets.

Cleaning and Inspection

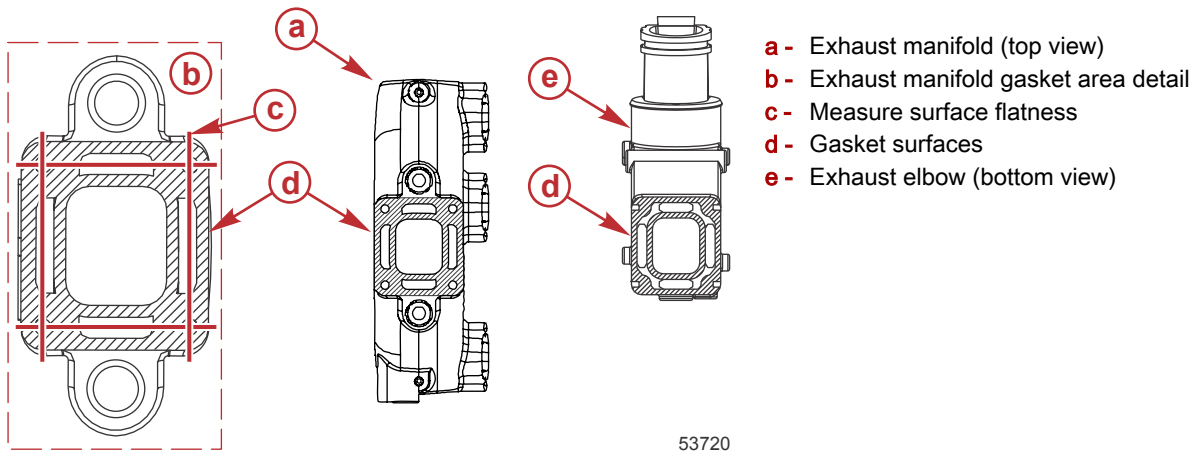
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for debris. The passages must be clean for efficient cooling.

NOTE: If a more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold and the exhaust elbow.

IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before installation.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Exhaust manifold and elbow plug threads	92-809822

3. Inspect for cracks.
4. Inspect all parts carefully. The machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
5. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser.
6. Measure the surface flatness of all gasket surfaces on the manifold, elbow, and riser.



Description	Maximum overall difference
Surface flatness	0.07 mm (0.003 in.)

NOTE: The maximum material that can be removed is 0.25 mm (0.010 in.). When tightening the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.

NOTE: The gasket is not reusable. Inspect for proper gasket replacement before disassembly and assembly.

7. Replace any damaged components.

Manifold Leak Test

NOTE: One block-off plate must have an attachment for a compressed air hose.

1. Using suitable block-off plates, plugs, and new gaskets, seal the manifold openings.
2. Attach an air hose to the block-off plate.
3. Apply 138 kPa (20 psi) of air pressure and submerge the manifold in water.
4. Air bubbles will indicate a leak. Repair or replace, if necessary.

Installation

1. Using a new gasket, install the exhaust manifold onto the cylinder head. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Exhaust manifold to cylinder head screw	43	–	32

2. Position a new gasket onto the top of the manifold.

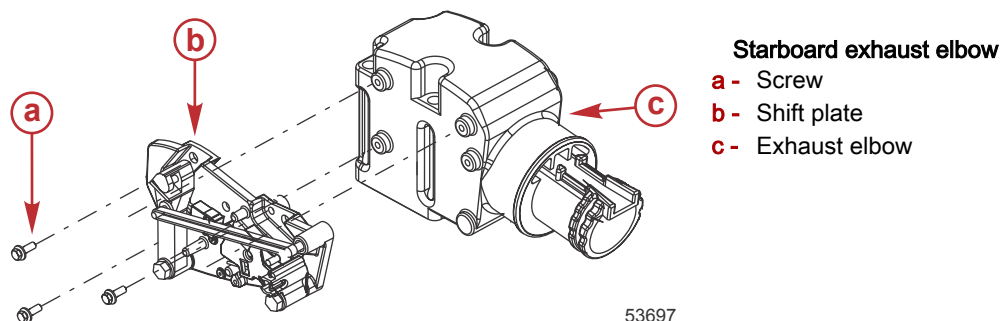
Manifolds, Elbows, and Risers for Wet Joint

3. For 76 mm (3 in.) risers, install studs into the manifold.
4. Install the exhaust riser and exhaust elbow onto the exhaust manifold. Refer to the appropriate exploded view.
NOTE: If a riser is used, be certain to position a new gasket between the riser and the exhaust elbow.
5. If applicable, install the remote oil assembly with exhaust elbow screws.
6. Tighten the screws or nuts to the specified torque.

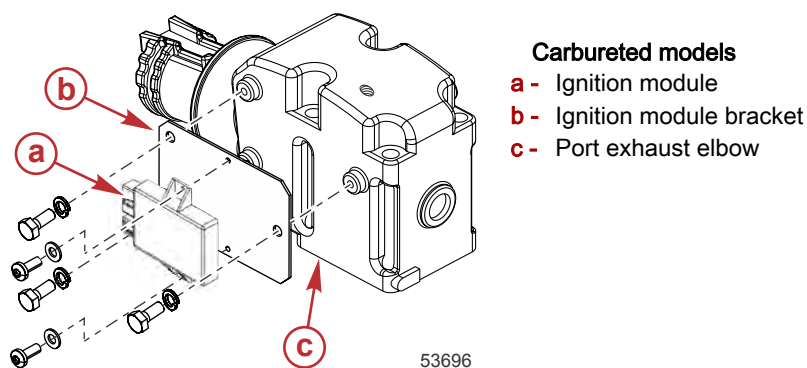
IMPORTANT: Tighten fasteners evenly using an X pattern from corner to corner.

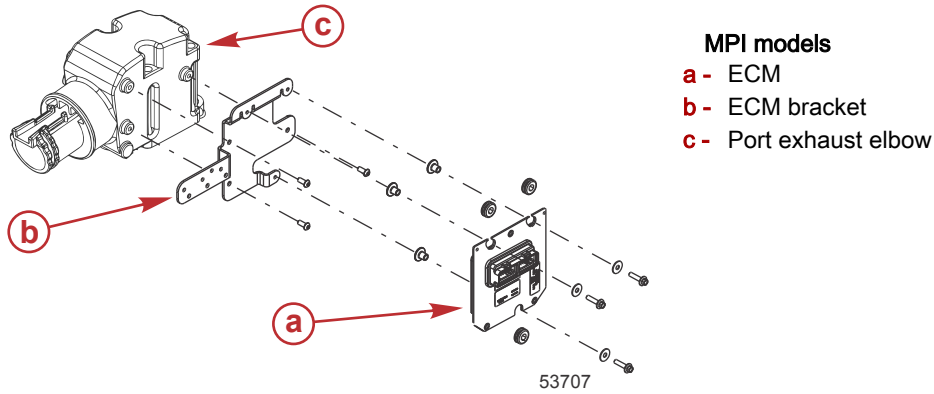
Description		Nm	lb-in.	lb-ft
Exhaust elbow or riser to exhaust manifold screw or nut	First pass	27	–	20
	Final pass	45	–	33

7. For starboard exhaust elbows:
 - a. Install the drop-down shift plate bracket, if equipped.
 - b. Install the shift plate assembly to the elbow.
 - c. Connect both shift cables.
 - d. Tighten the screws securely.
 - e. Connect the instrument harness plug to the engine harness, and install the screw to secure the water-separating fuel filter bracket to the exhaust manifold, if disconnected previously.



8. Port exhaust elbow:
 - a. Install the ECM drop-down bracket, if equipped.
 - b. Install the ECM bracket and the ECM or the ignition module bracket and ignition module to the exhaust elbow.
 - c. Tighten securely.





9. Install the exhaust hoses and the cooling hoses.
10. Tighten the hose clamps securely.
11. Install any additional components removed during disassembly.
12. Connect the battery cables to the battery. Tighten securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

13. Supply cooling water to the engine.
14. Start the engine and check for exhaust and water leaks.

Notes:

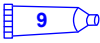
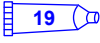
Exhaust System

Section 7C - Manifolds, Elbows, and Risers for Dry Joint

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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Pipe plug threads	92-809822
		Hose fitting threads	
		Hose fitting and pipe plug threads	
 19	Perfect Seal	Bare metal gasket sealing surface	92-34227Q02
		Edge of water ports on the exhaust manifold and exhaust elbow	
		Exhaust elbow screw threads	
		Edge of water ports on the exhaust manifold, riser, and exhaust elbow	

General Information

Seawater Cooled Models

The term seawater cooled, also known as raw water cooled (RWC), refers to the use of water, such as seawater, for cooling throughout the system, in the engine cooling passages and in the exhaust water jackets. This water source is picked up through the sterndrive and engine seawater pump.

Warm Manifolds

Warm manifolds contain fluid that enters the exhaust manifold near thermostat operating temperature. The temperature is warm enough to evaporate moisture that collects on interior exhaust passages due to condensation. All dry-joint models are warm manifold engines.

Dry Joint

Dry joint is a description based on the style of exhaust system on these engines. In a dry-joint exhaust system the engine seawater and the exhaust gas are separated by different gasket sealing surfaces at the exhaust manifold to elbow joint (dry joint). In the exhaust elbow, the engine seawater and exhaust gases mix and discharge together.

Full Loop Closed Cooling Systems

Full loop closed cooling systems use an ethylene glycol mixture to cool the engine and exhaust manifolds. The hot glycol mixture is circulated through the heat exchanger tubes, engine block, and exhaust manifold water jackets. Heat transfer occurs when cool raw water from the sea pump flows through the heat exchanger and is discharged into the exhaust stream at the exhaust elbows.

All current production MerCruiser engines equipped with closed cooling kits use full loop systems.

Dry Joint Component Identification

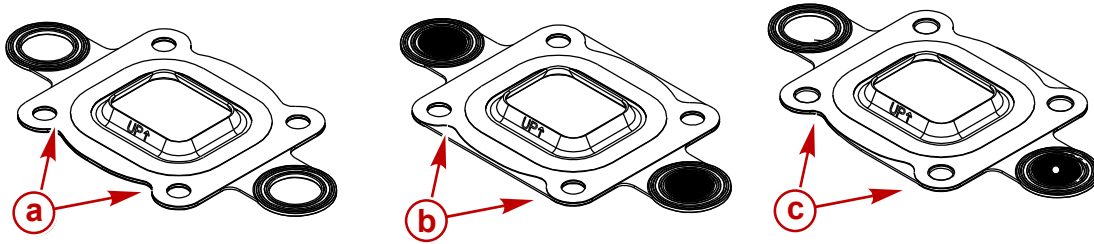
Turbulator Gaskets

IMPORTANT: Only use the Mercury turbulator gasket specified for your engine package. Engine damage that results from improper gasket use is considered misuse of the engine and is not covered under Mercury MerCruiser Warranty.

IMPORTANT: Gasket identification can be viewed externally on the engine package. The outer edge of each turbulator gasket identifies the gasket and the gasket position.

- The full flow gasket is contoured at the edge to show full flow at each water port.
- The block-off gasket is straight at the edge to show no flow at each port.

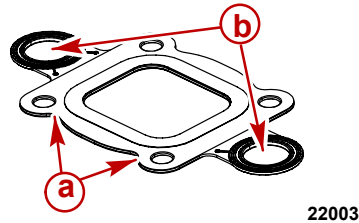
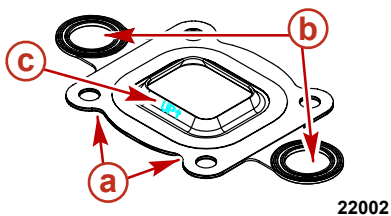
- The restrictor gasket is contoured at one edge of the gasket to allow full flow. The other edge of the gasket is straight to show restricted flow.



31689

- a - Full flow gasket
- b - Block-off gasket
- c - Restrictor gasket

- Full flow gaskets on models with a serial number of 0W309999 and below had a turbulator. Models with a serial number of 0W310000 and above were equipped with full flow gaskets without a turbulator. Full flow gaskets with or without a turbulator are interchangeable.



Full flow gasket with turbulator

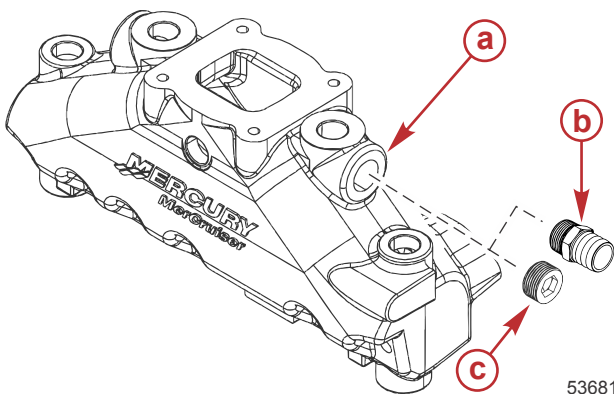
- a - Edge of gasket contoured to show full flow at each water port
- b - Passages fully open
- c - Turbulator facing up

Standard full flow gasket without turbulator

NOTE: Gaskets are not reusable. Inspect the exhaust system for proper gasket replacement before disassembly and assembly.

Exhaust Manifold

The dry-joint exhaust manifold cannot be replaced with the wet-joint exhaust manifold design.



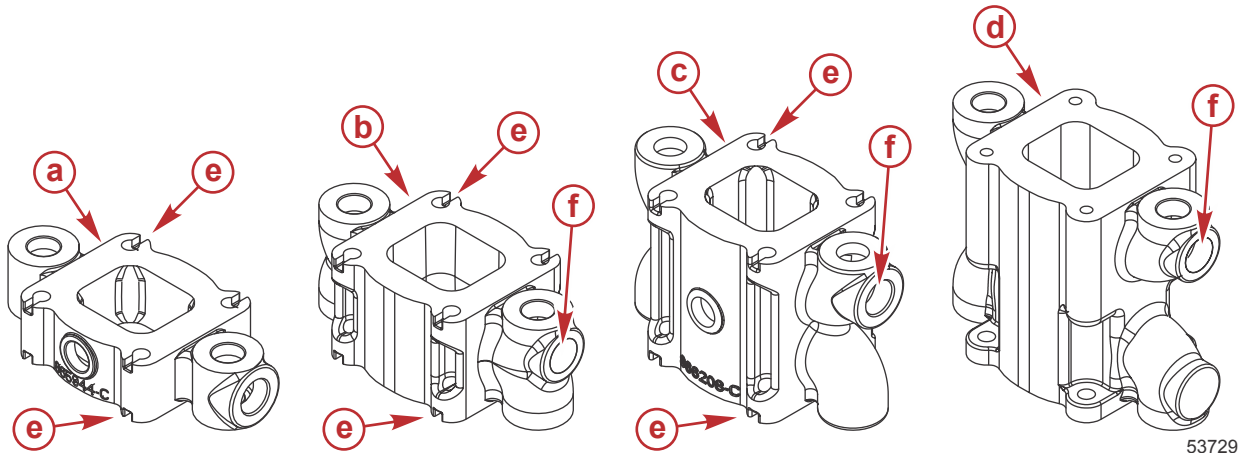
Exhaust manifold

- a - Outlet water port
- b - Hose fitting
- c - Pipe plug

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Dry-Joint Riser Casting

IMPORTANT: The risers identified here are new casting designs and cannot be replaced with the previous Mercury MerCruiser riser castings.



- a - 43 mm (1.7 in.) riser
- b - 76 mm (3.0 in.) riser
- c - 119 mm (4.7 in.) riser
- d - 152 mm (6.0 in.) riser
- e - Drain holes
- f - Water port positioned to the top side of the casting, closest to the exhaust elbow

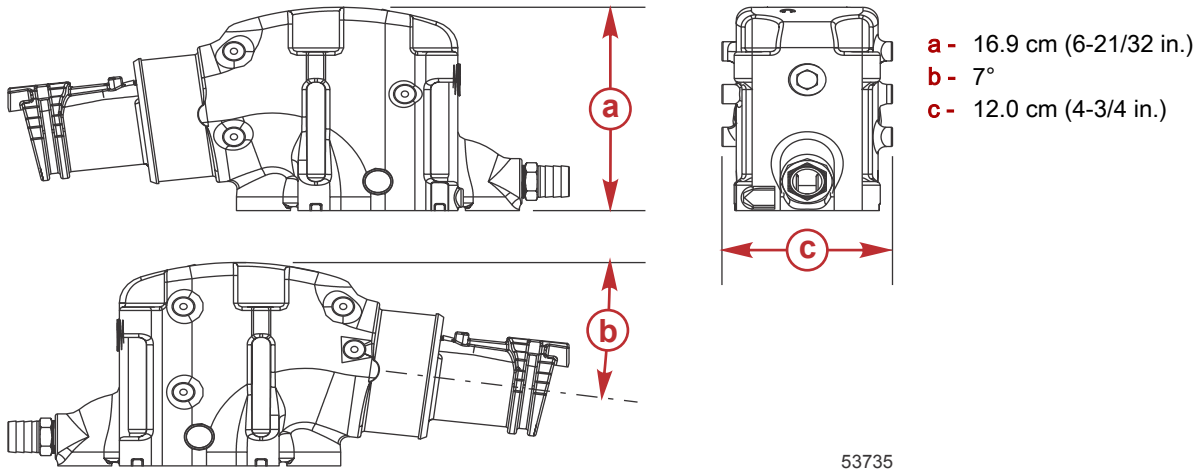
NOTE: Some early 119 mm (4.7 in.) riser applications were achieved by stacking 43 mm (1.7 in.) and 76 mm (3.0 in.) risers. The 119 mm (4.7 in.) riser shown above is a direct replacement for this combination.

Exhaust Elbow

The exhaust elbows identified are new casting designs and should not be replaced with previous Mercury MerCruiser elbow castings.

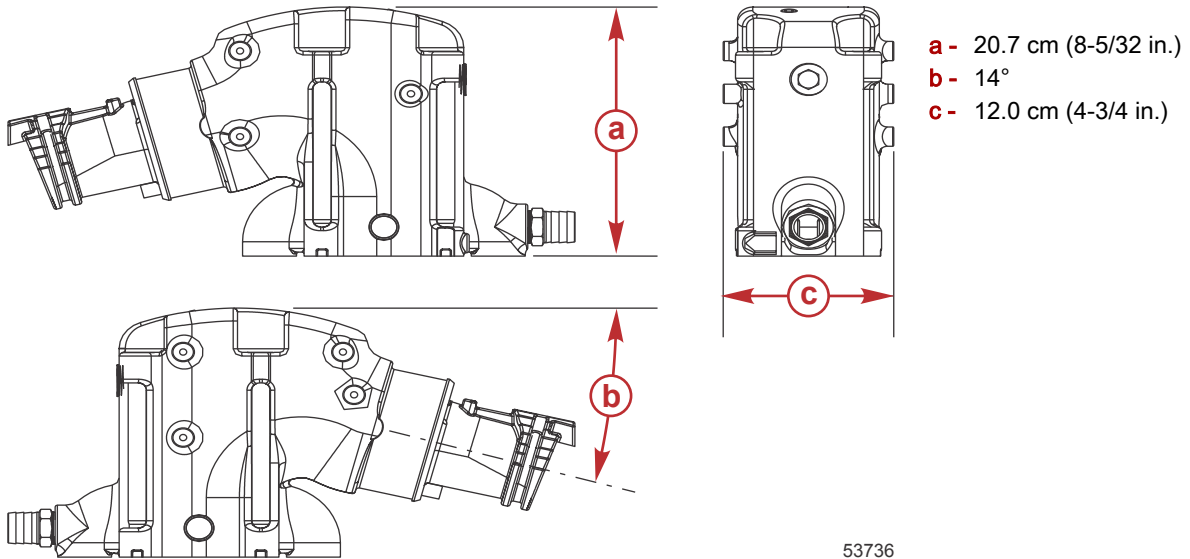
7° Elbow

Models Covered	Serial Number Or Year
All models	0W309999 and below



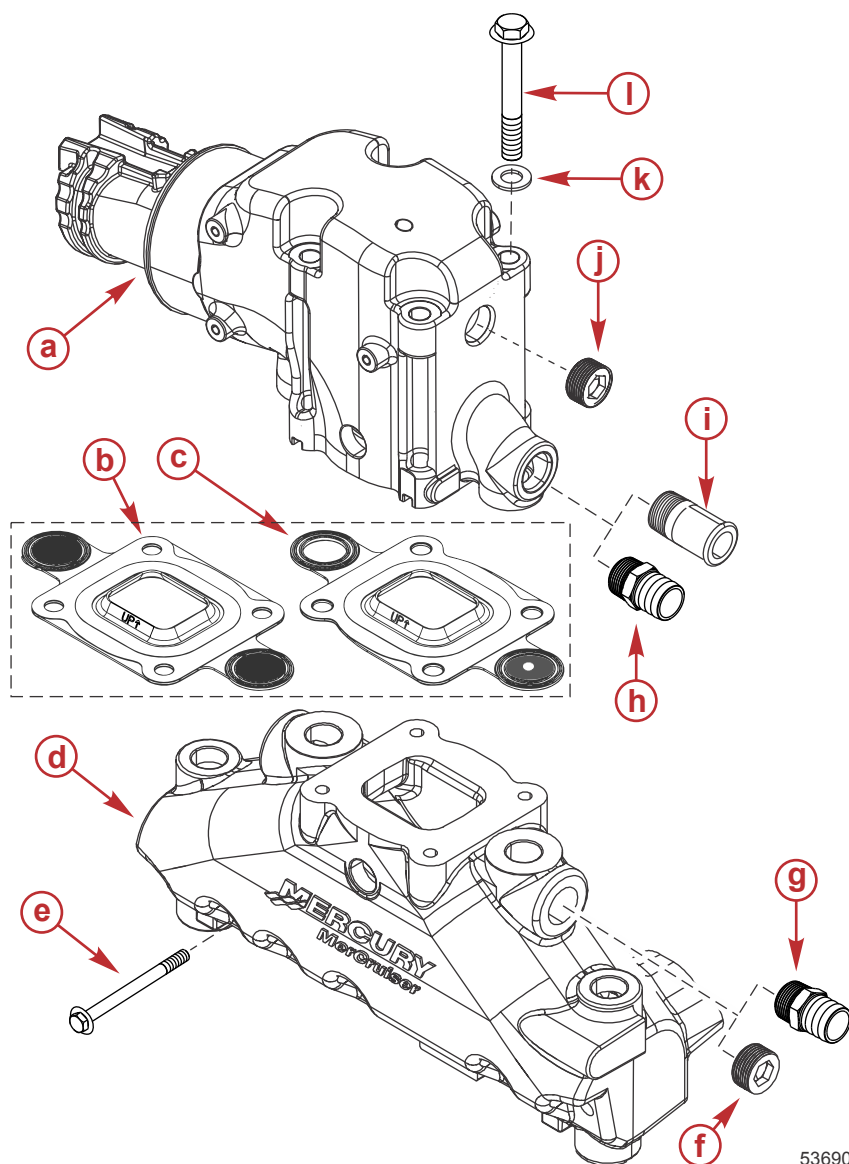
14° Elbow

Models Covered	Serial Number Or Year
All models	0W310000 and above



Exploded View

All Models without Risers—Exploded View



- a** - Exhaust elbow
- b** - Block-off gasket (models with closed cooling)
- c** - Restrictor gasket (models with seawater cooling)

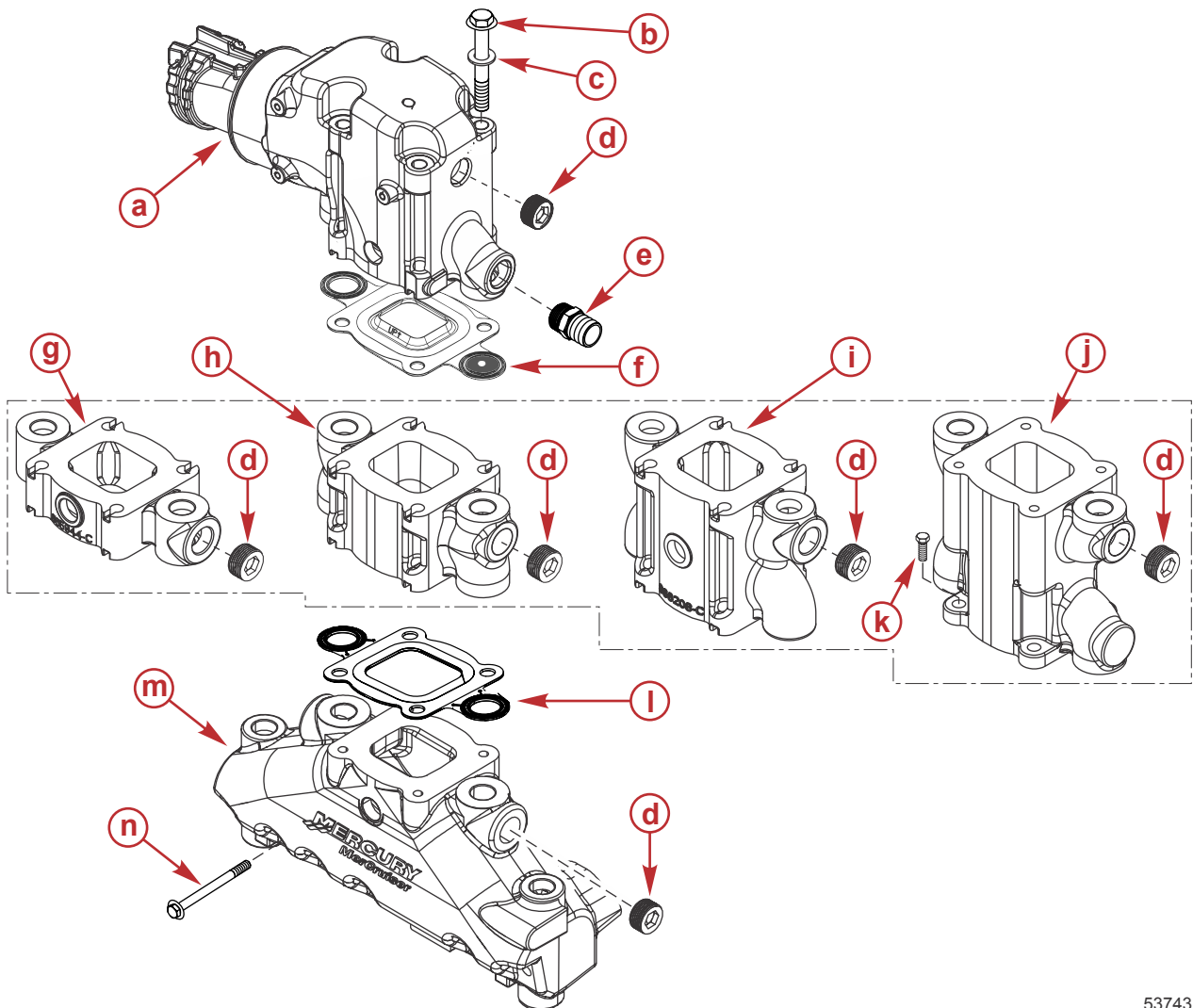
NOTE: The restricted port must be positioned on the seawater inlet side of the elbow.

- d** - Exhaust manifold
- e** - Manifold-to-cylinder-head screw
- f** - Pipe plug (models with seawater cooling)
- g** - Hose fitting (models with closed cooling)
- h** - Hose fitting (MPI models)
- i** - Hose fitting (carbureted models)
- j** - Pipe plug
- k** - Washer (models S/N 0W309999 and below)
- l** - Exhaust-elbow-to-manifold screw

53690

Models with Risers and Seawater Cooling—Exploded View

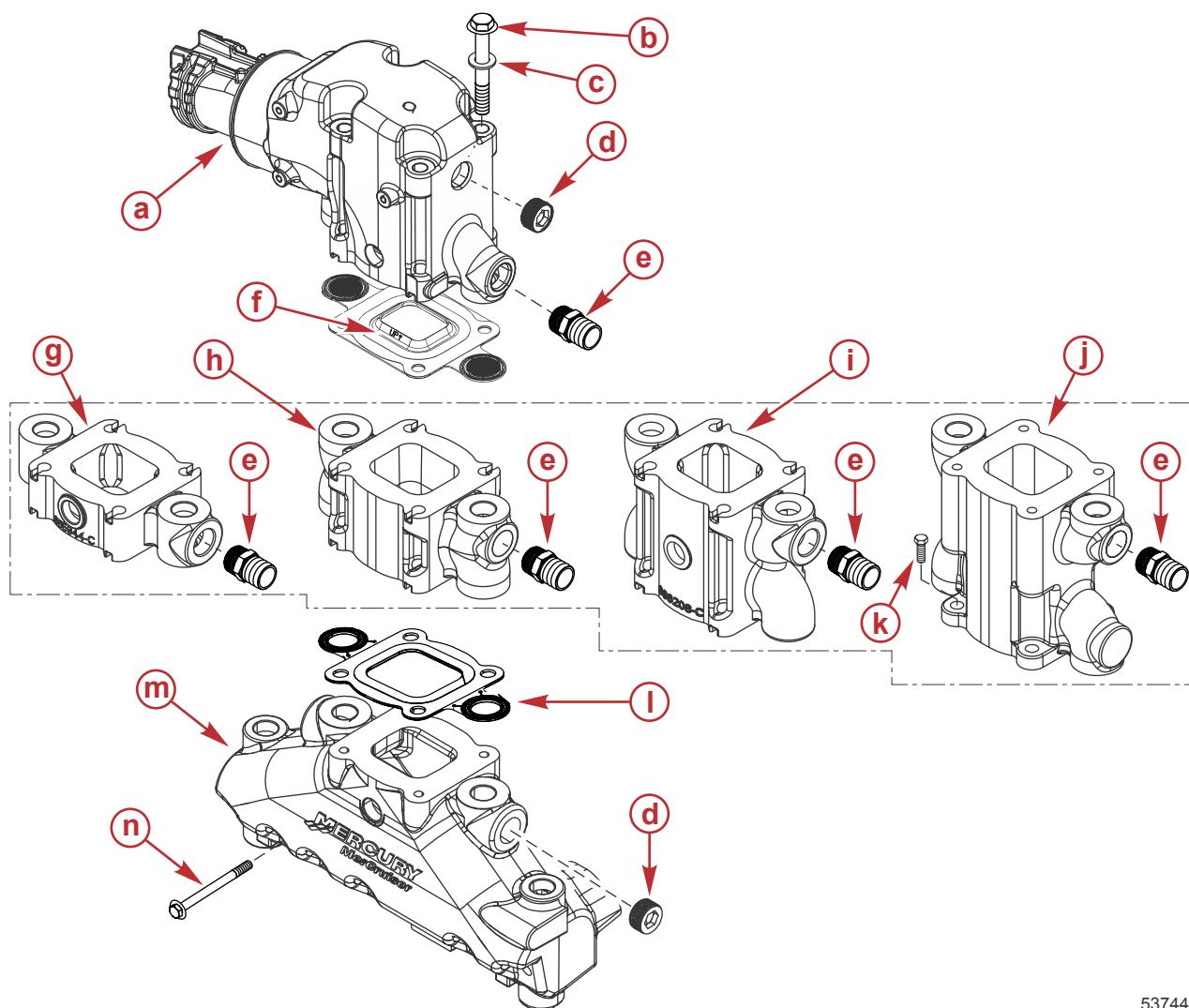
IMPORTANT: On models with seawater cooling, always position the restrictor gasket with the restricted port on the same side of the exhaust manifold as the hose fitting.



53743

- a** - Exhaust elbow
- b** - Exhaust-elbow-to-manifold screw or (152 mm [6.0 in.] riser only) exhaust-elbow-to-riser screw
- c** - Washer (models S/N 0W309999 and below)
- d** - Pipe plug
- e** - Hose fitting
- f** - Restrictor gasket (restricted port positioned on the fitting side of the riser)
- g** - 43 mm (1.7 in.) riser
- h** - 76 mm (3.0 in.) riser
- i** - 119 mm (4.7 in.) riser
- j** - 152 mm (6.0 in.) riser
- k** - Riser-to-manifold screw (152 mm [6.0 in.] riser only)
- l** - Full flow gasket
- m** - Exhaust manifold
- n** - Manifold-to-cylinder-head screw

Models with Risers and Closed Cooling—Exploded View



53744

- a** - Exhaust elbow
- b** - Exhaust-elbow-to-manifold screw or (152 mm [6.0 in.] riser only) exhaust-elbow-to-riser screw
- c** - Washer (models S/N 0W309999 and below)
- d** - Pipe plug
- e** - Hose fitting
- f** - Block-off gasket (turbulator facing up)
- g** - 43 mm (1.7 in.) riser
- h** - 76 mm (3.0 in.) riser
- i** - 119 mm (4.7 in.) riser
- j** - 152 mm (6.0 in.) riser
- k** - Riser-to-manifold screw (152 mm [6.0 in.] riser only)
- l** - Full flow gasket
- m** - Exhaust manifold
- n** - Manifold-to-cylinder-head screw

Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect both battery cables from the battery.
2. For models with seawater cooling, drain the seawater section of the engine.
3. For models with closed cooling, drain the coolant section of the engine. Refer to **Section 6C**.
4. Disconnect the engine exhaust hoses. Retain the fasteners.
5. Disconnect all hoses from the exhaust manifold, riser, and exhaust elbow. Retain the fasteners.
6. Remove the shift plate.
7. For MPI models, remove the ECM and the ECM bracket.
8. Remove and retain any other components that are mounted to the exhaust manifold, riser, and elbow.
9. Remove the exhaust elbow and riser, if equipped. Retain the fasteners.
10. Remove the exhaust manifold. Retain the fasteners.
11. Discard the used gaskets.

Cleaning and Inspection

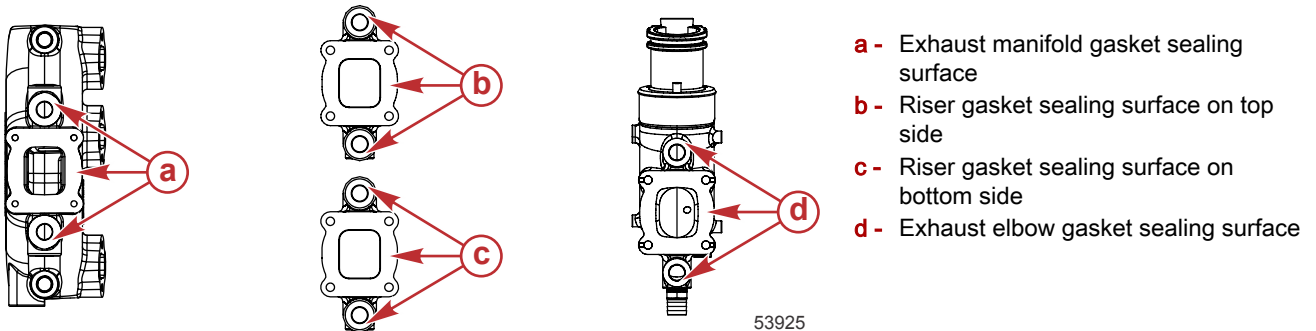
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for debris. The passages must be clean for efficient cooling.

NOTE: If a more thorough inspection is desired, remove the pipe plugs from the exhaust manifold and the exhaust elbow.

IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before reinstalling them.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Pipe plug threads	92-809822

3. Inspect the manifold, elbow, and riser for cracks.
4. Inspect all parts carefully. The machined surfaces must be clean and free of all marks and deep scratches, or water or exhaust leaks may result.
5. Inspect the parts for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser.
6. Use a straightedge and feeler gauge to measure the surface flatness of all gasket surfaces on the manifold, elbow, and riser.



NOTE: Only use this specification if the gasket surfaces on used exhaust components have to be machined to remove minor corrosion.

Description	Maximum Overall Difference
Surface flatness	0.07 mm (0.003 in.)

NOTE: The maximum material that can be removed is 0.25 mm (0.010 in.). When tightening the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.

NOTE: The gasket is not reusable. Inspect the exhaust for proper gasket replacement before disassembly and assembly.

- Replace all damaged components.

Manifold Leak Test

NOTE: One block-off plate must have an attachment for a compressed air hose.

- Using suitable block-off plates, plugs, and new gaskets, seal the manifold openings.
- Attach an air hose to the block-off plate.
- Apply 138 kPa (20 psi) of air pressure and submerge the manifold in water.
- Air bubbles will indicate a leak. Repair or replace, if necessary.

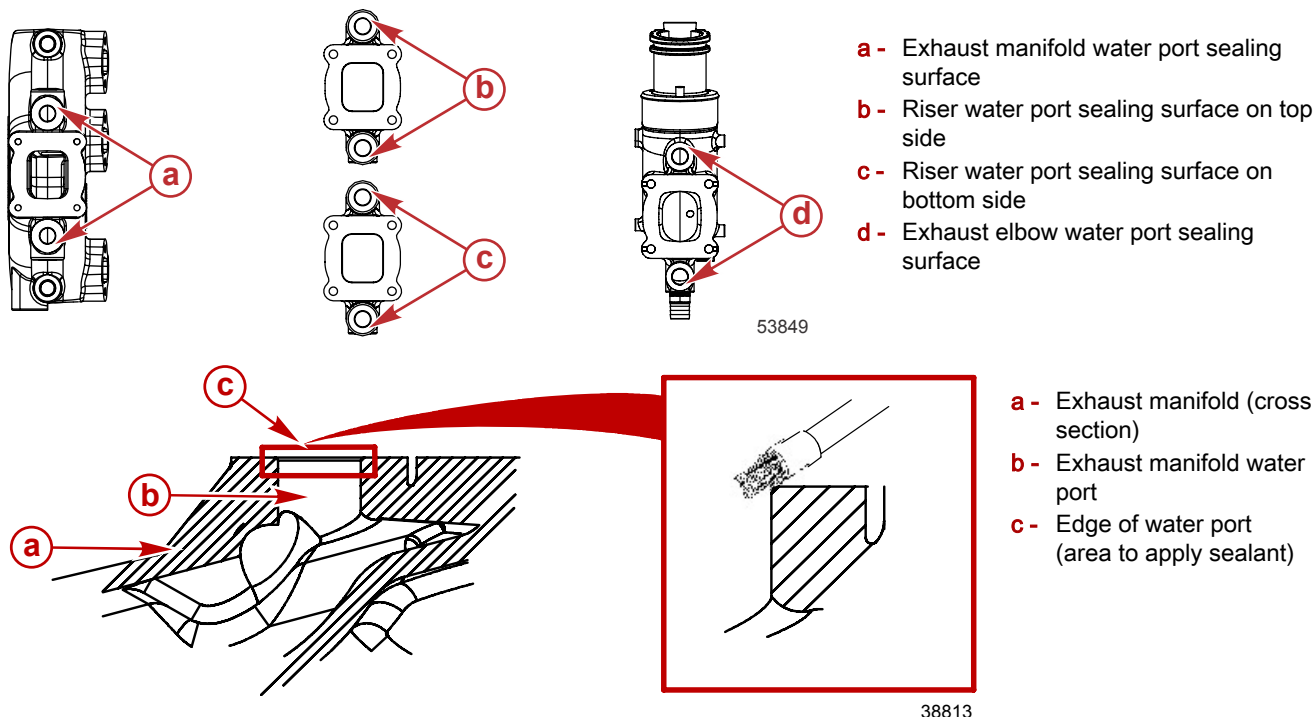
Assembly Notice

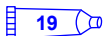
IMPORTANT: The edge of the water ports on all cast iron parts must be coated with Perfect Seal during assembly.

IMPORTANT: Apply Perfect Seal to any bare metal that is present on the gasket sealing surface.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Bare metal gasket sealing surface	92-34227Q02

If the exhaust elbow assembly is disassembled or risers are added, apply sealant to the edge of all water ports (the exhaust manifold, both sides of the riser, and the exhaust elbow).



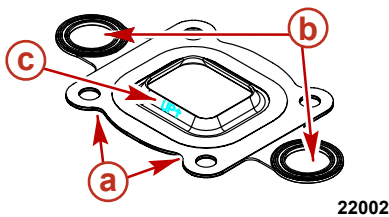
Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227Q02

Gasket Application

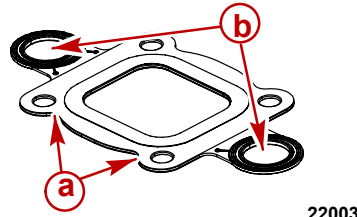
Full Flow Gasket

Models Covered	Serial Number Range	Description
Engines with dry-joint manifolds and risers	0W309999 and below	Full flow gasket with turbulator
	0W310000 and above	Full flow gasket without turbulator

IMPORTANT: On models with risers, the full flow gasket must be placed between the exhaust manifolds and the riser.



22002



22003

Full flow gasket with turbulator

- a - Edge of gasket contoured to show full flow at each water port
- b - Passages fully open
- c - Turbulator facing up

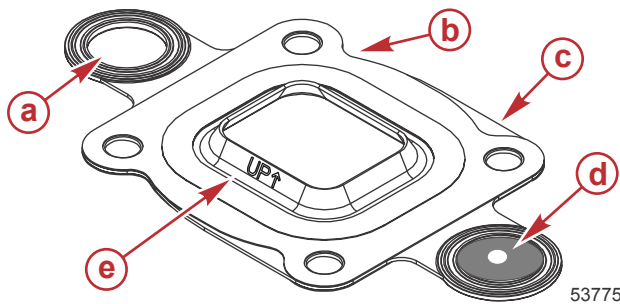
Standard full flow gasket without turbulator

Restrictor Gasket

Models Covered	Description
Models with seawater cooling	Restrictor gasket

IMPORTANT: On models without risers, the restrictor gasket must be placed between the exhaust manifold and the exhaust elbow. On models with risers, the restrictor gasket must be placed between the riser and the exhaust elbow.

IMPORTANT: The restrictor end of the gasket must be positioned to the seawater inlet side of the exhaust elbow.



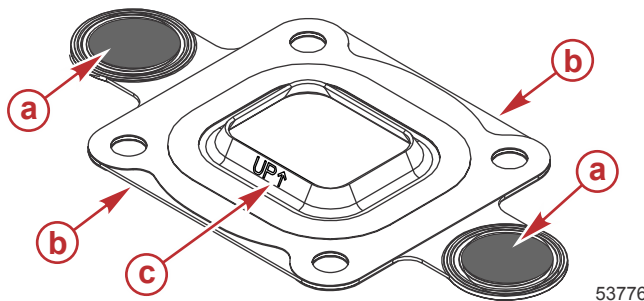
53775

- a - Full flow passage
- b - Contoured gasket edge to indicate full flow water port
- c - Straight gasket edge at one end only to indicate restricted flow water port
- d - Restricted flow passage
- e - Turbulator oriented up

Block-Off Gasket

Models Covered	Description
Models with closed cooling	Block-off gasket

IMPORTANT: On models without risers, the block-off gasket must be placed between the exhaust manifold and the exhaust elbow. On models with risers, the block-off gasket must be placed between the riser and the exhaust elbow.



53776

- a - No opening for water flow
- b - Straight gasket edge at both ends of the gasket to indicate blocked-off water ports
- c - Turbulator oriented up

Exhaust Manifold Installation

1. Models with seawater cooling:

- a. Apply sealant to the threads of the pipe plug, and install it into the exhaust manifold.

Manifolds, Elbows, and Risers for Dry Joint

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Pipe plug threads	92-809822

- b. Tighten the pipe plug to the specified torque.

Description	Nm	lb-in.	lb-ft
Exhaust manifold pipe plug	50	–	37

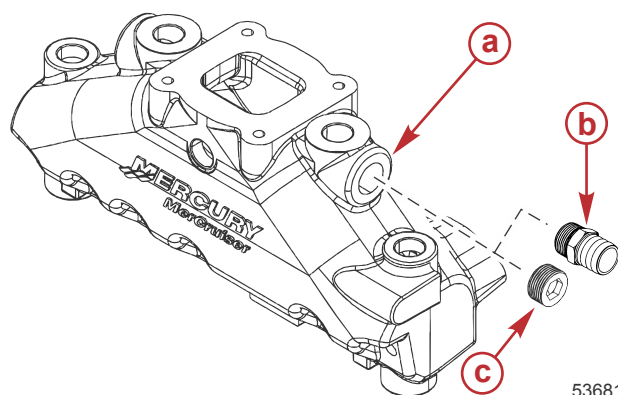
2. Models with closed cooling:

- a. Apply sealant to the threads of the hose fitting, and install it into the exhaust manifold.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting threads	92-809822

- b. Tighten the hose fitting to the specified torque.

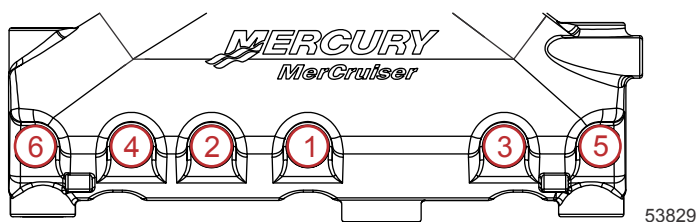
Description	Nm	lb-in.	lb-ft
Exhaust manifold hose fitting	50	–	37



Exhaust manifold

- a - Outlet water port
- b - Hose fitting (models with closed cooling)
- c - Pipe plug (models with seawater cooling)

3. Using a new exhaust manifold gasket, install the exhaust manifold onto the cylinder head. Tighten the fasteners to the specified torque, making three passes and following the sequence shown.



Exhaust manifold fastener torque sequence

Description		Nm	lb-in.	lb-ft
Exhaust-manifold-to-cylinder-head screw	First	20.3	180	15
	Second	33.9	–	25
	Final	47.5	–	35

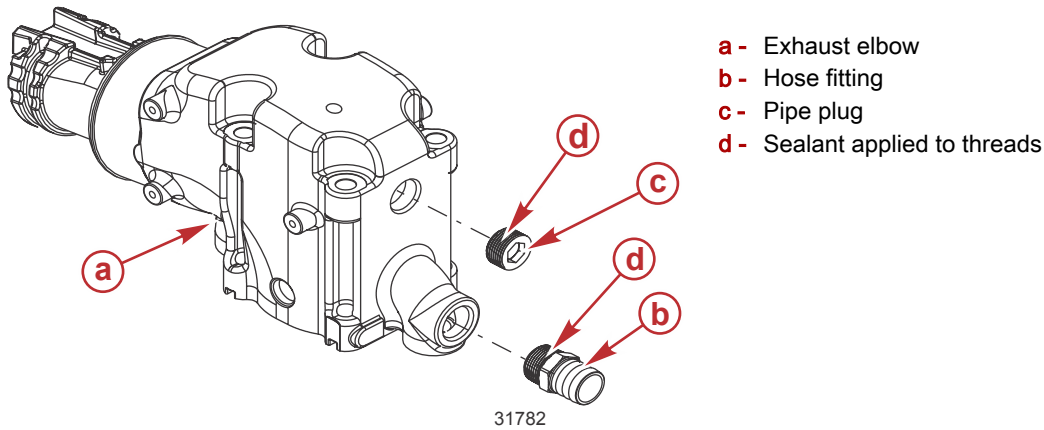
4. Install the exhaust elbow and riser, if equipped. Refer to **Exhaust Elbow Installation without Risers** or **Exhaust Elbow Installation with Risers**, as applicable.

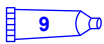
Exhaust Elbow Installation without Risers

IMPORTANT: The correct turbulator gasket must be properly installed to avoid overheating due to insufficient water flow or coolant loss through the exhaust.

IMPORTANT: If risers are used, refer to Exhaust Elbow Installation with Risers.

1. Apply sealant to the threads of the hose fitting and pipe plug, and install them in the exhaust elbow.

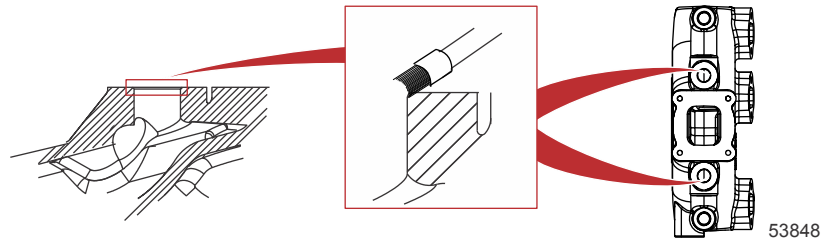


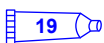
Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting and pipe plug threads	92-809822

2. Tighten the hose fitting and pipe plug to the specified torque.

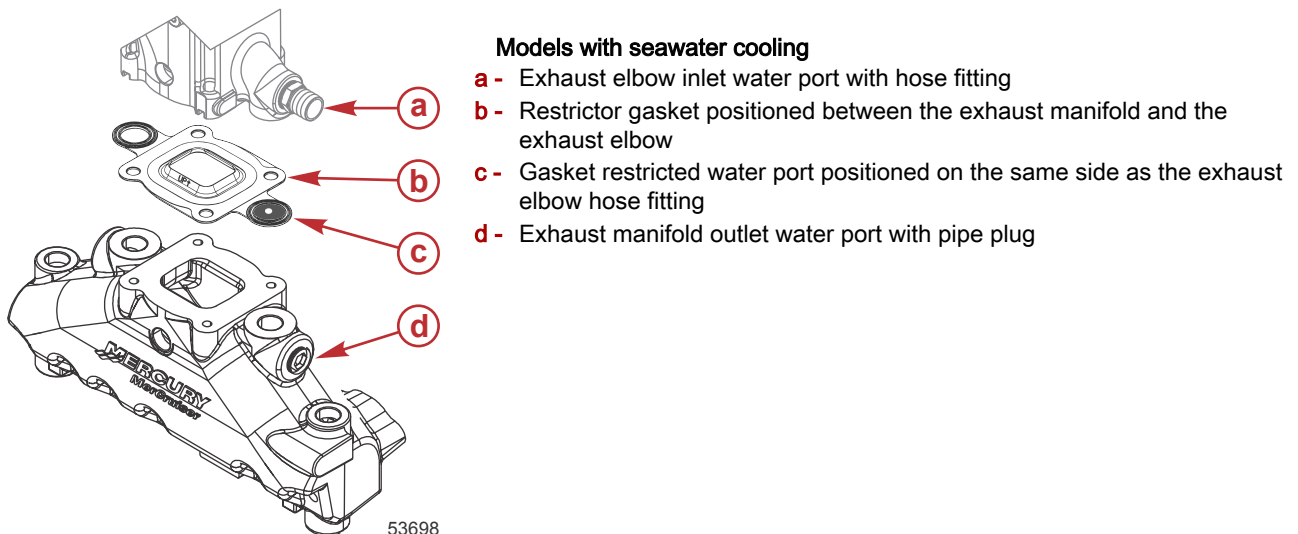
Description	Nm	lb-in.	lb-ft
Exhaust elbow hose fitting and pipe plug	50	–	37

3. Apply sealant to the edge of each of the two water ports located on the exhaust manifold.



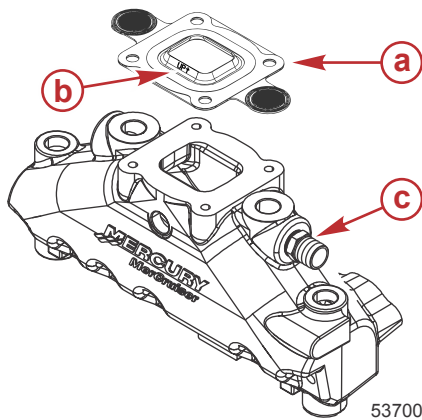
Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227Q02

4. Models with seawater cooling: Place the restrictor gasket onto the exhaust manifold with the side marked "UP" visible. Ensure that the restricted water port of the restrictor gasket is on the same side as the exhaust elbow hose fitting.



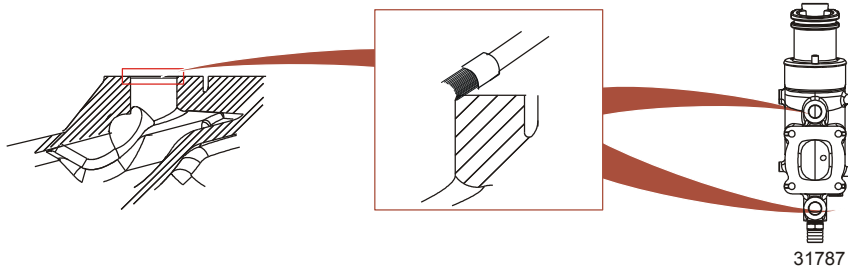
Manifolds, Elbows, and Risers for Dry Joint

5. Models with closed cooling: Place the block-off gasket onto the exhaust manifold with the side marked "UP" visible.



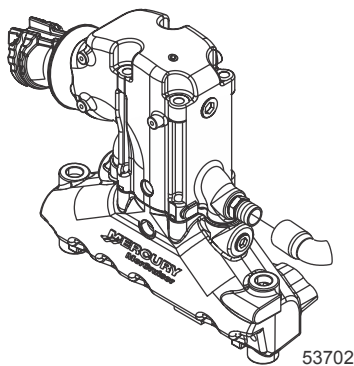
- Models with closed cooling**
- a - Block-off gasket positioned on the exhaust manifold
 - b - "UP" marking on the turbulator
 - c - Exhaust manifold outlet coolant port with hose fitting

6. Apply sealant to the edge of each of the two water ports located on the exhaust elbow.

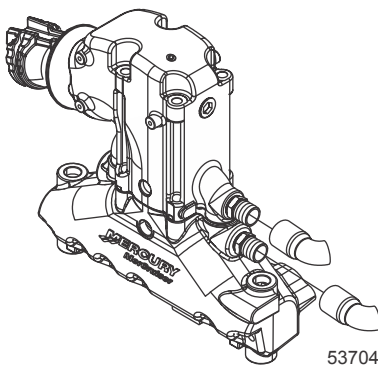


Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227Q02

7. Place the exhaust elbow onto the exhaust manifold.



Model with seawater cooling



Model with closed cooling

IMPORTANT: To ensure correct torque, the exhaust elbow screws without a flanged head require that a specific flat washer be used in conjunction with the screw. If a flange head screw is used, no washer is needed. Refer to the appropriate Mercury Marine parts catalog.

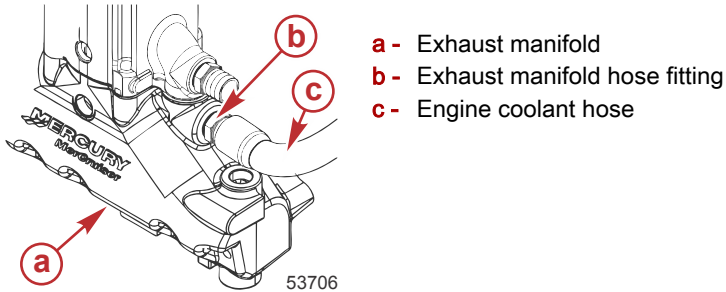
8. If applicable, assemble washers onto the exhaust elbow screws.
9. Apply sealant to exhaust elbow screw threads and hand-start them to temporarily secure the assembly.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Exhaust elbow screw threads	92-34227Q02

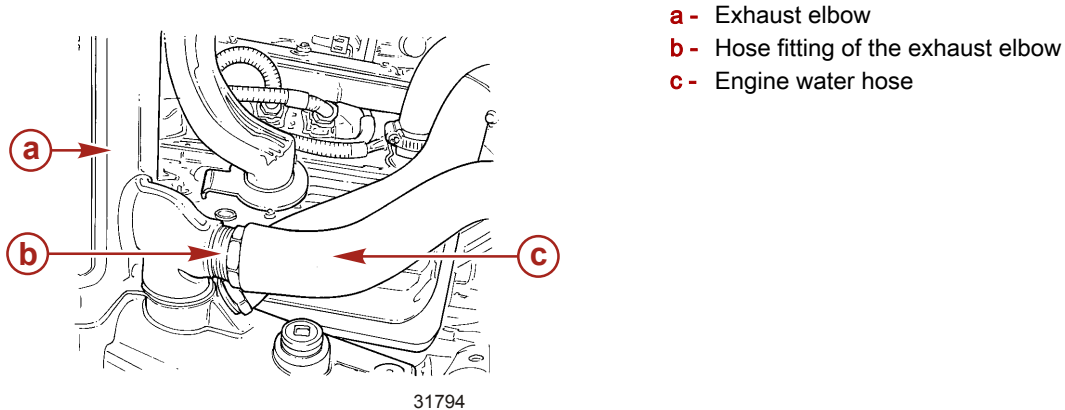
10. Align the exhaust elbow to the engine exhaust system.
- NOTE:** The gasket is not reusable. Inspect the system for proper gasket and component position before torquing.
11. Tighten the exhaust elbow fasteners to the specified torque.
- IMPORTANT:** Tighten the fasteners evenly using an X-pattern from corner to corner.

Description		Nm	lb-in.	lb-ft
Exhaust-elbow-to-exhaust-manifold screw or nut	First	9.5	84	7
	Final	61	–	45

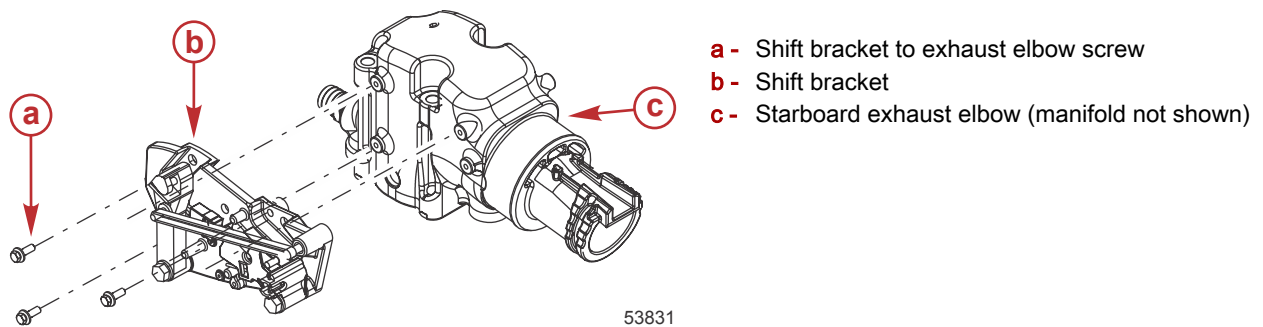
12. Models with seawater cooling: Connect the engine water hoses to the exhaust elbows and tighten the hose clamps securely.
13. Models with closed cooling: Connect the engine coolant hose from the thermostat housing to the hose fitting on the top of the exhaust manifold. Tighten the hose clamps securely.



14. Models with closed cooling: Connect the engine water hose from the heat exchanger to the exhaust elbow and tighten the hose clamps securely.



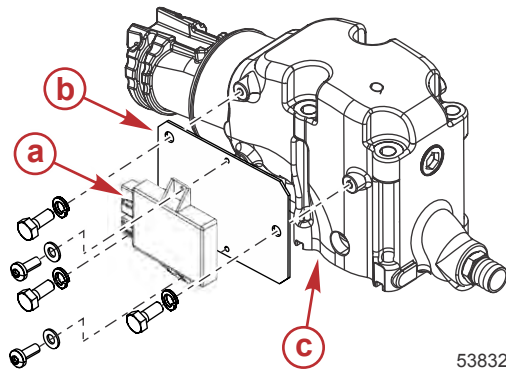
15. Install the shift plate assembly onto the exhaust elbow.



16. Connect both shift cables. Refer to **Section 2B - Installation**.

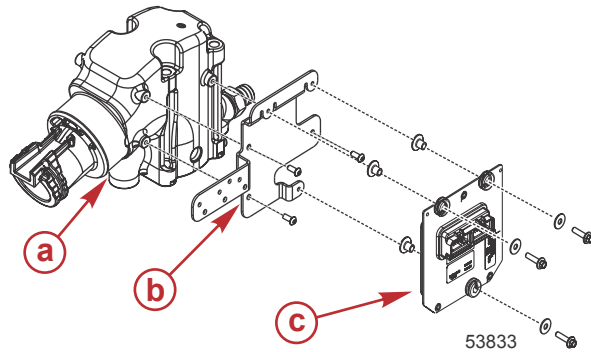
Manifolds, Elbows, and Risers for Dry Joint

17. Install the ECM and ECM bracket or the ignition module and ignition module bracket on the port exhaust elbow.



Carbureted models

- a - Ignition module
- b - Ignition module bracket
- c - Port exhaust elbow (manifold not shown)



MPI models

- a - Port exhaust elbow (manifold not shown)
- b - ECM bracket
- c - ECM

18. Secure the engine exhaust system.
19. Install any additional components removed during disassembly.
20. Models with closed cooling: Fill the closed cooling system to the operating level. Refer to **Section 6C**.
21. Reconnect the battery cables to the battery. Tighten securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

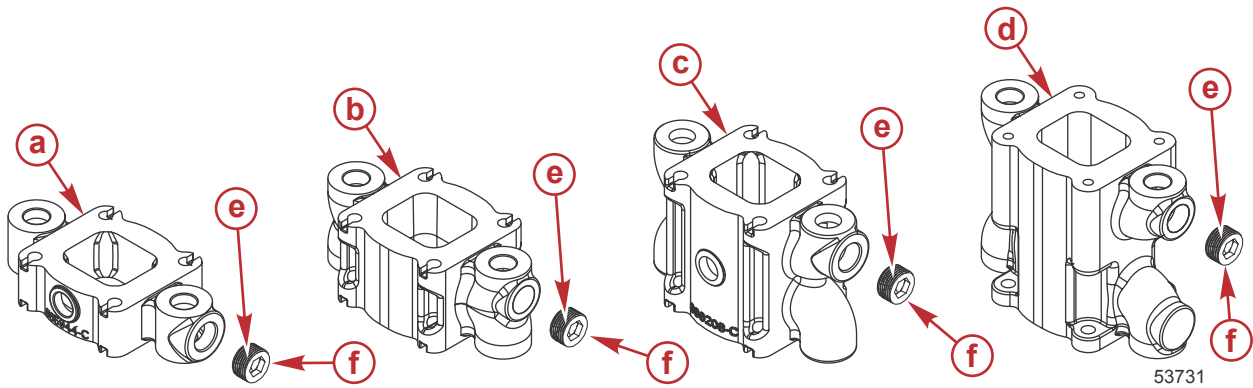
22. Supply cooling water to the engine.
23. Start the engine and check for exhaust and water leaks.

Exhaust Elbow Installation with Risers

IMPORTANT: The correct turbulator gasket must be properly installed to avoid overheating due to insufficient water flow or coolant loss through the exhaust.

1. For models with seawater cooling:

- a. Apply sealant to the threads of the pipe plug, and install the plug into the riser.



Models with seawater cooling

- a - 43 mm (1.7 in.) riser
- b - 76 mm (3.0 in.) riser
- c - 119 mm (4.7 in.) riser
- d - 152 mm (6.0 in.) riser
- e - Sealant applied to threads
- f - Pipe plug

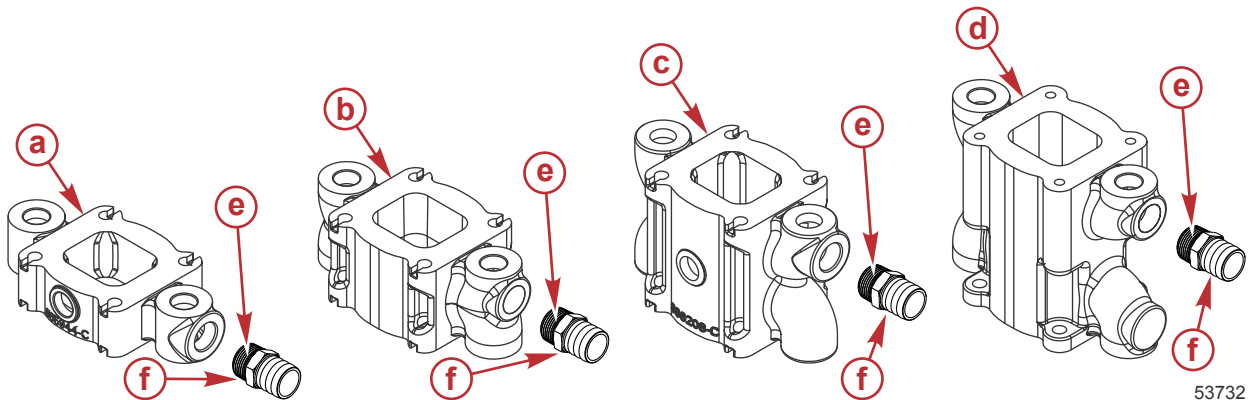
Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Pipe plug threads	92-809822

- b. Tighten the pipe plug to the specified torque.

Description	Nm	lb-in.	lb-ft
Pipe plug to riser	50	–	37

2. For models with closed cooling:

- a. Apply sealant to the threads of the hose fittings and install the fittings into the risers.



Models with closed cooling

- a - 43 mm (1.7 in.) riser
- b - 76 mm (3.0 in.) riser
- c - 119 mm (4.7 in.) riser
- d - 152 mm (6.0 in.) riser
- e - Sealant applied to threads
- f - Hose fitting

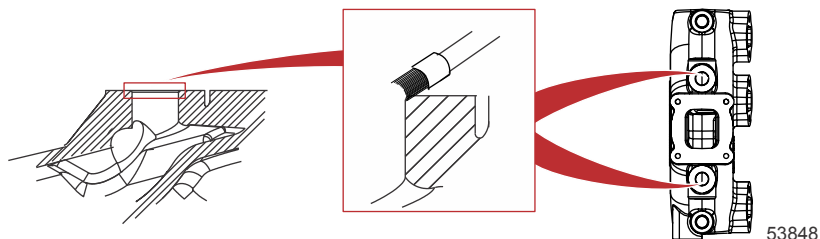
Manifolds, Elbows, and Risers for Dry Joint

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting threads	92-809822

- b. Tighten the hose fitting to the specified torque.

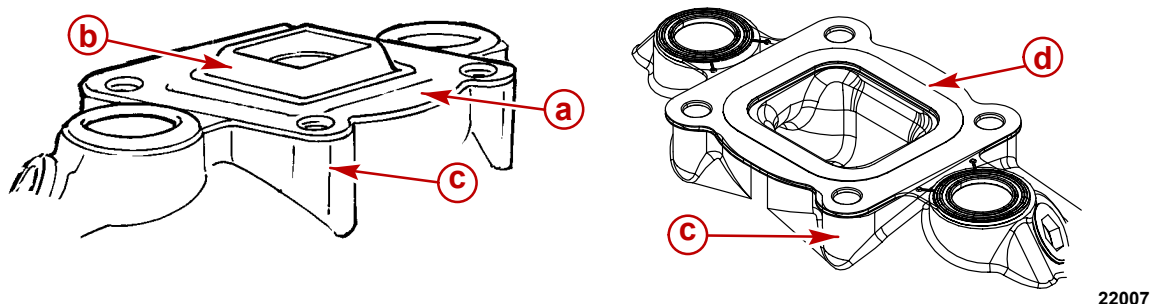
Description	Nm	lb-in.	lb-ft
Hose fitting to riser	50	–	37

3. Apply sealant to the edge of each of the two water ports located on the exhaust manifold.



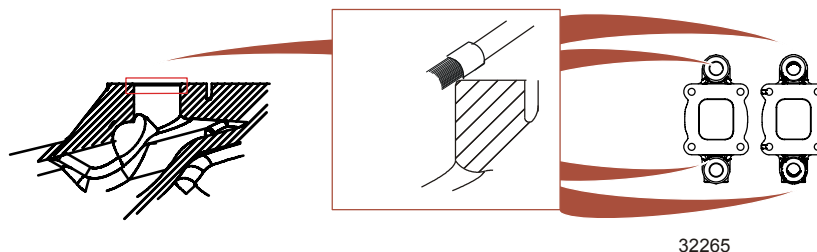
Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227Q02

4. Place the full flow gasket onto the exhaust manifold. If the gasket has a turbulator, ensure that it is positioned with the side marked "UP" visible.



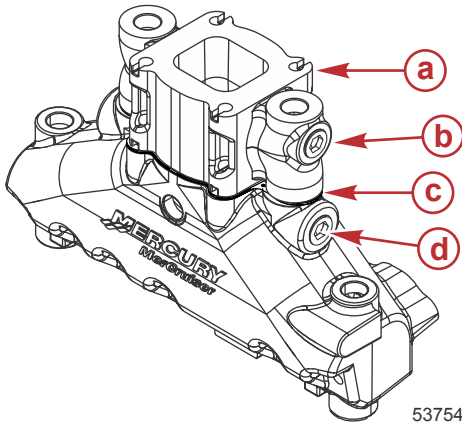
- a - Full flow gasket with turbulator
- b - Turbulator
- c - Exhaust manifold
- d - Standard (nonturbulator) full flow gasket

5. Apply sealant to the edge of each of the four water ports located on the riser.



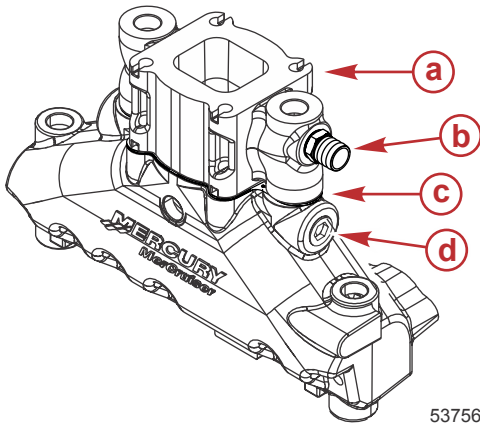
Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227Q02

6. Place the riser onto the exhaust manifold as shown.



Models with seawater cooling

- a - Exhaust riser—76 mm (3.0 in.) riser shown, other risers similar
- b - Riser outlet water port with pipe plug
- c - Full flow gasket between riser and manifold
- d - Exhaust manifold outlet water port with pipe plug

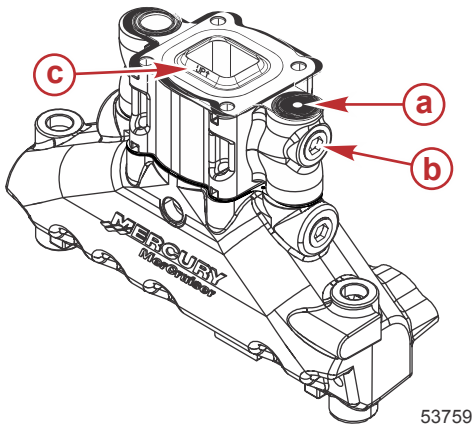


Models with closed cooling

- a - Exhaust riser—76 mm (3.0 in.) riser shown, other risers similar
- b - Riser outlet water port with hose fitting
- c - Full flow gasket between riser and manifold
- d - Exhaust manifold outlet water port with pipe plug

IMPORTANT: For models with closed cooling, ensure that the riser outlet water port with hose fitting is positioned toward the top of the riser (closest to the elbow) and is on the correct side to accept the engine coolant hose. When the elbow is installed, the hose fitting on the elbow should be directly above the hose fitting on the riser.

7. For 152 mm (6.0 in.) riser models, install and hand-tighten the screws to temporarily secure the riser and gasket to the exhaust manifold.
8. For models with seawater cooling, place the restrictor gasket on the riser with the side marked "UP" visible. Ensure that the restricted water port of the restrictor gasket is on the same side as the riser outlet water port.

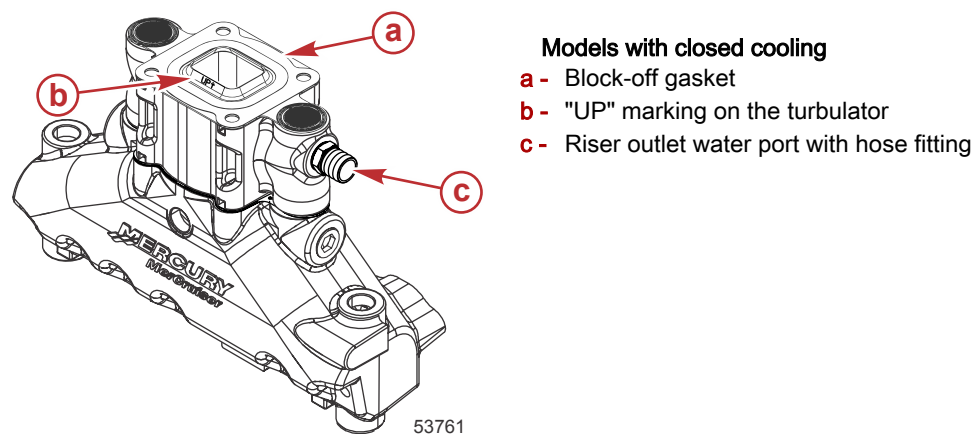


Models with seawater cooling

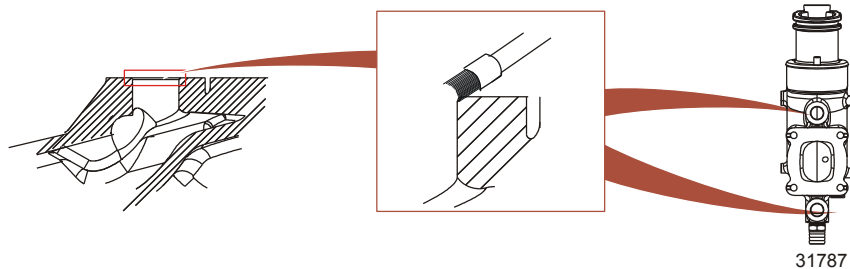
- a - Restricted water port of the restrictor gasket
- b - Riser outlet water port with pipe plug
- c - "UP" marking on the restrictor gasket

Manifolds, Elbows, and Risers for Dry Joint

9. For models with closed cooling, place the block-off gasket on the riser with the side marked "UP" visible.



10. Apply sealant to the edge of each of the two water ports located on the exhaust elbow.

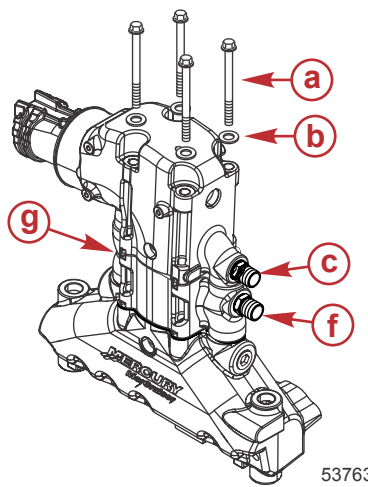
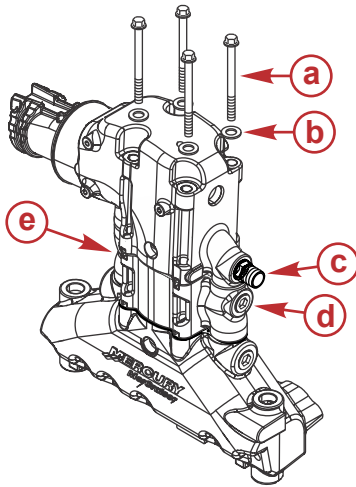


Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227Q02

11. Place the exhaust elbow onto the riser.
IMPORTANT: To ensure the correct torque, the exhaust elbow screws without a flanged head require that a specific flat washer be used in conjunction with the screw. If a flange head screw is used, no washer is needed. Refer to the appropriate Mercury Marine parts catalog.
12. If applicable, assemble washers onto the exhaust elbow screws.
13. Apply sealant to exhaust elbow screw threads, and hand-start the screws to temporarily secure the assembly.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Exhaust elbow screw threads	92-34227Q02

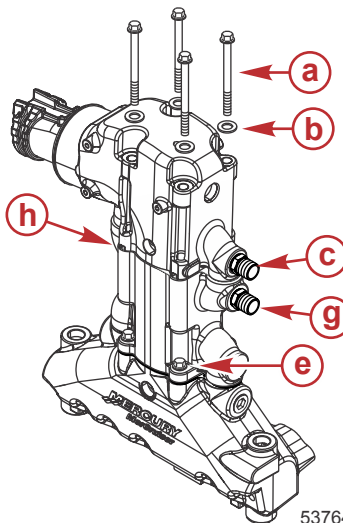
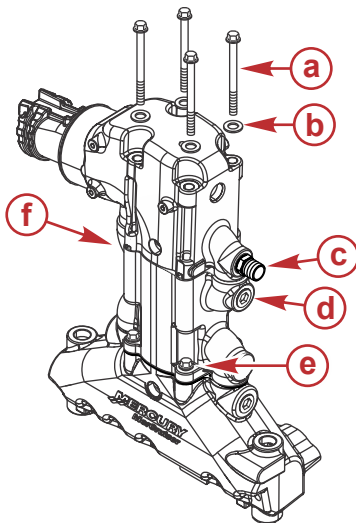
14. Align the exhaust elbow to the engine exhaust system.



53763

76 mm (3.0 in) riser shown, 43 mm (1.7 in.) and 119 mm (4.7 in.) risers are similar

- a - Elbow and riser to manifold screw
- b - Washer (used only on S/N 0W309999 and below)
- c - Exhaust elbow seawater inlet port with hose fitting
- d - Riser water outlet port with pipe plug (models with seawater cooling)
- e - Restrictor gasket positioned between riser and elbow (models with seawater cooling)
- f - Riser water outlet port with hose fitting (models with closed cooling)
- g - Block-off gasket positioned between riser and elbow (models with closed cooling)



53764

Models with 152 mm (6.0 in.) risers

- a - Elbow-to-riser screw
- b - Washer (used only on S/N 0W309999 and below)
- c - Exhaust elbow seawater inlet port with hose fitting
- d - Riser water outlet port with pipe plug (models with seawater cooling)
- e - Riser-to-manifold screw
- f - Restrictor gasket positioned between riser and elbow (models with seawater cooling)
- g - Riser water outlet port with hose fitting (models with closed cooling)
- h - Block-off gasket positioned between riser and elbow (models with closed cooling)

15. For 152 mm (6.0 in.) riser models, tighten the riser-to-manifold screw to the specified torque.

NOTE: The gasket is not reusable. Inspect the exhaust for proper gasket and component position before tightening.

Description		Nm	lb-in.	lb-ft
Riser-to-manifold screw	First pass	9.5	84	7
	Final pass	61	–	45

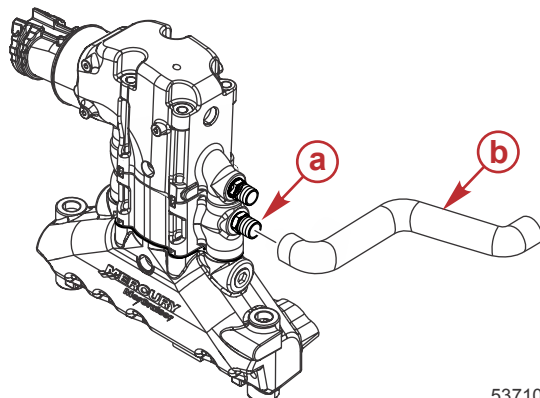
16. Tighten the exhaust elbow fasteners to the specified torque.

Description		Nm	lb-in.	lb-ft
Exhaust elbow fasteners	First pass	9.5	84	7
	Final pass	61	–	45

17. For models with seawater cooling, connect the engine water hoses to the exhaust elbows and tighten the hose clamps securely.

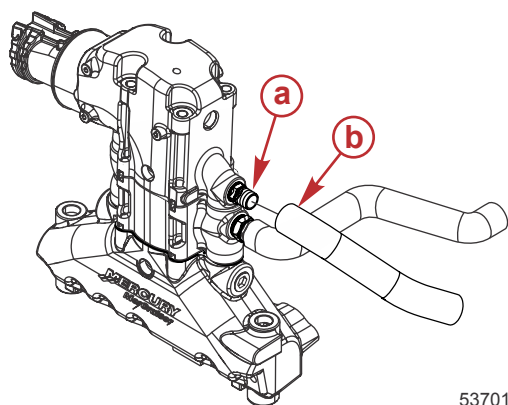
18. For models with closed cooling:

- a. Connect the coolant hose from the thermostat housing to the hose fitting of the riser. Tighten the hose clamps securely.



- a - Hose fitting on the riser
- b - Engine coolant hose

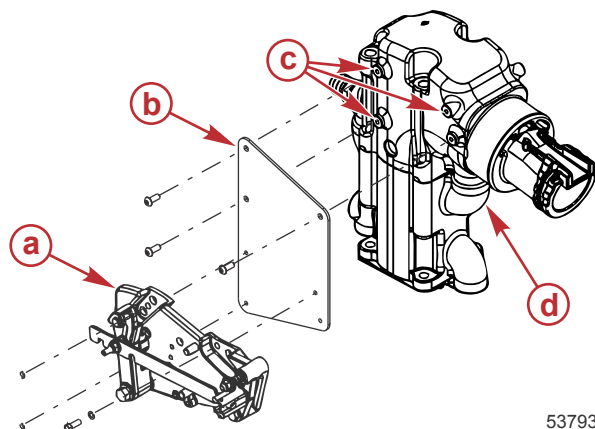
- b. Connect the engine water hose from the heat exchanger to the exhaust elbow fitting and tighten the hose clamps securely.



- a - Exhaust elbow fitting
- b - Engine water hose

19. Starboard exhaust elbow:

- a. For the 119 mm (4.7 in.) and 152 mm (6.0 in.) risers, install the drop-down shift plate bracket.
- b. Install the shift plate assembly onto the drop-down shift plate bracket or the exhaust elbow, as applicable.
- c. Securely tighten the fasteners.



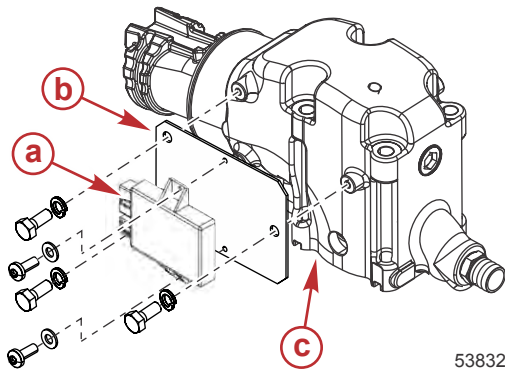
Drop-down bracket for shift bracket

- a - Shift bracket
- b - Drop-down bracket
- c - Bracket mounting holes
- d - Exhaust elbow and riser assembly (manifold not shown)—152 mm (6.0 in.) riser shown, 119 mm (4.7 in.) riser similar

20. Port exhaust elbow:

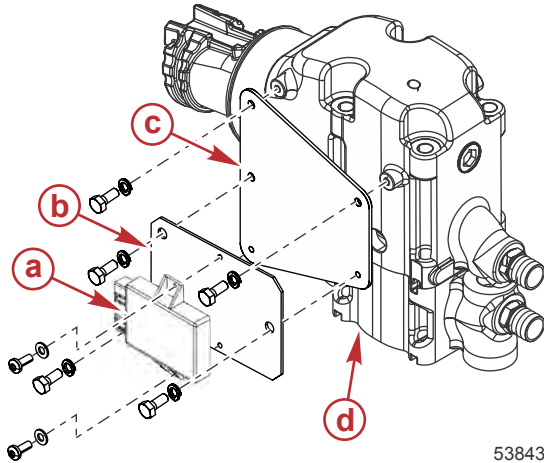
- a. For the 76 mm (3.0 in.), 119 mm (4.7 in.), and 152 mm (6.0 in.) risers, install the ECM drop-down bracket.
- b. Install the ECM and ECM bracket or the ignition module and ignition module bracket onto the exhaust elbow.

c. Securely tighten all fasteners.



Ignition module bracket for the 43 mm (1.7 in.) riser assembly for carbureted models

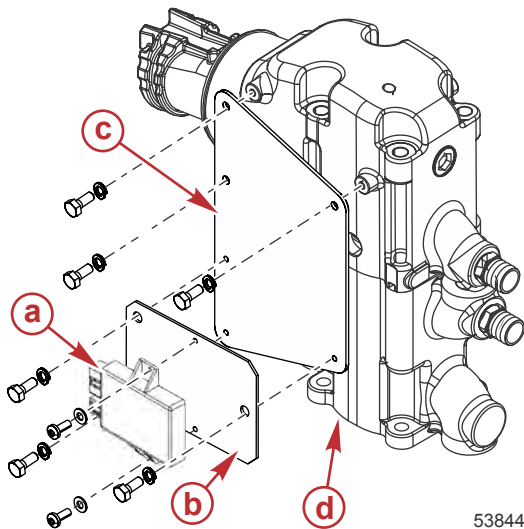
- a - Ignition module
- b - Ignition module bracket
- c - Port exhaust elbow (riser and manifold not shown)



Drop-down bracket for the ignition module on carbureted models with a 76 mm (3.0 in.) riser

- a - Ignition module
- b - Ignition module bracket
- c - Drop-down bracket
- d - Exhaust elbow and riser assembly (manifold not shown)

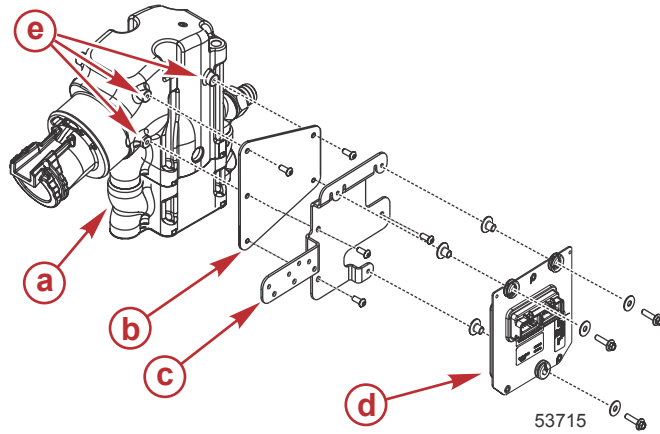
NOTE: Model with closed cooling is shown; model with seawater cooling is similar.



Drop-down bracket for the ignition module on carbureted models with a 119 mm (4.7 in.) or 152 mm (6.0 in.) riser

- a - Ignition module
- b - Ignition module bracket
- c - Drop-down bracket
- d - Exhaust elbow and riser assembly (manifold not shown)

NOTE: A model with closed cooling is shown; models with seawater cooling are similar. A 152 mm (6.0 in.) riser is shown; 119 mm (4.7 in.) riser applications are similar.

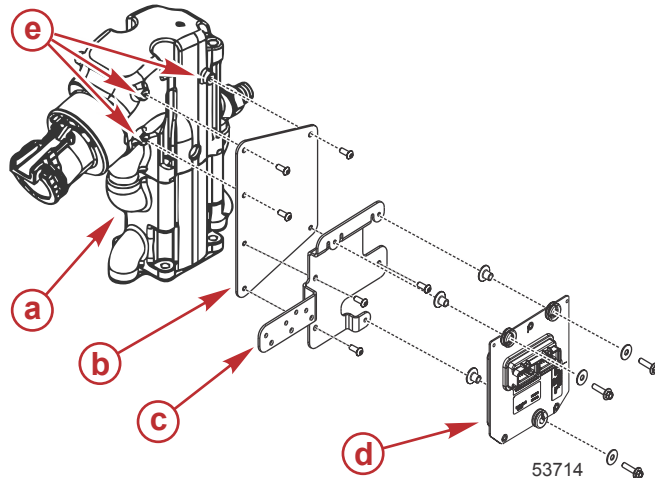


Drop-down bracket for the 43 mm (1.7 in.) and 76 mm (3.0 in.) riser assembly for MPI models

- a** - Exhaust riser and elbow assembly (manifold not shown)

NOTE: A 76 mm (3.0 in.) riser is shown; 43 mm (1.7 in.) riser applications are similar.

- b** - ECM drop-down bracket
c - ECM bracket
d - ECM
e - Bracket mounting holes



Drop-down bracket for the 119 mm (4.7 in.) and 152 mm (6.0 in.) riser assembly for MPI models

- a** - Exhaust riser and elbow assembly (manifold not shown)

NOTE: A 152 mm (6.0 in.) riser is shown; 119 mm (4.7 in.) riser applications are similar.

- b** - ECM drop-down bracket
c - ECM bracket
d - ECM
e - Bracket mounting holes

21. Install the exhaust hoses and the remaining cooling hoses.
22. Tighten the hose clamps securely.
23. Install any additional components removed during disassembly.
24. Reconnect the battery cables to the battery. Tighten them securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

25. Supply cooling water to the engine.
26. Start the engine and check for exhaust and water leaks.

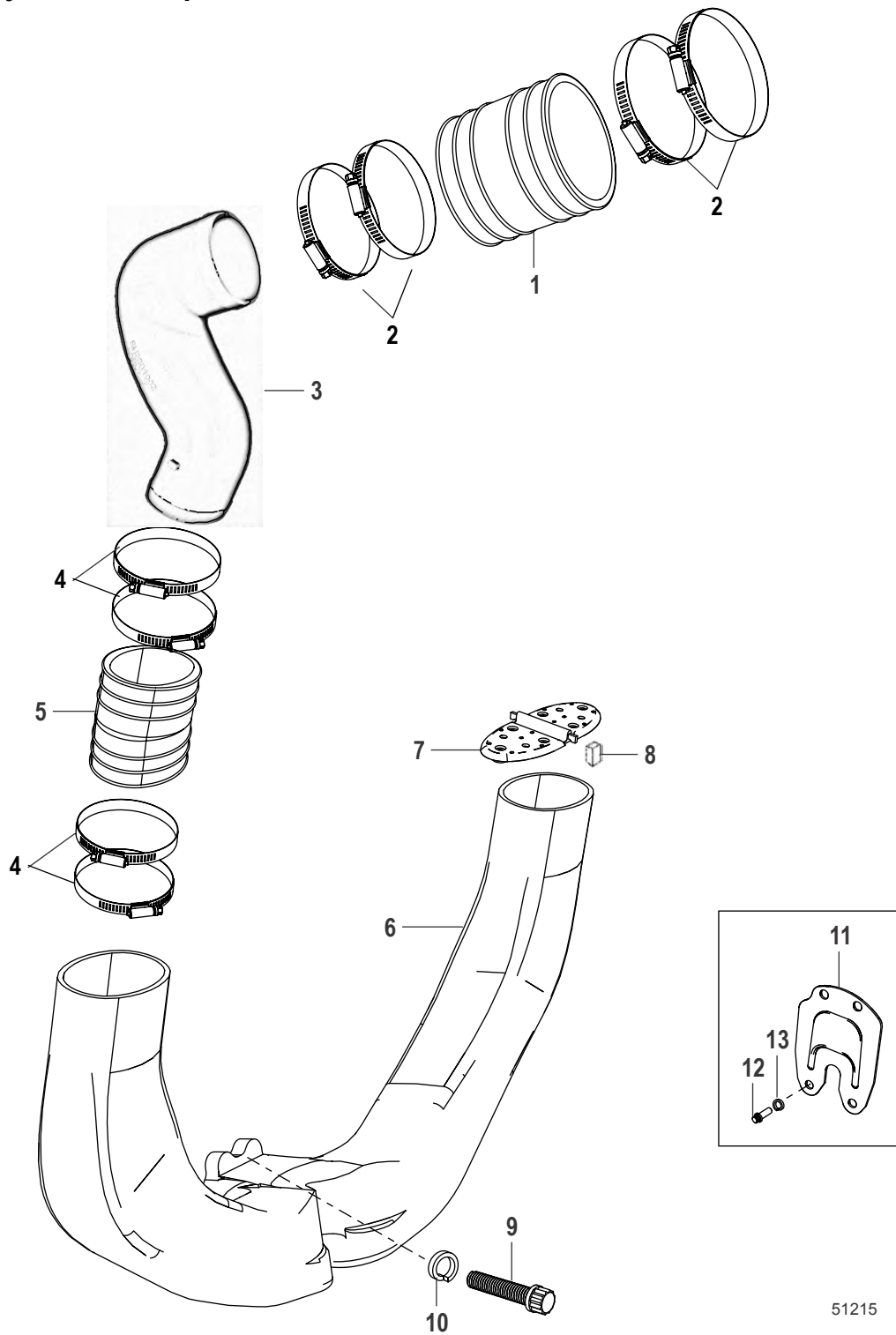
Exhaust System

Section 7D - Collectors

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Exhaust System Components—Sterndrive



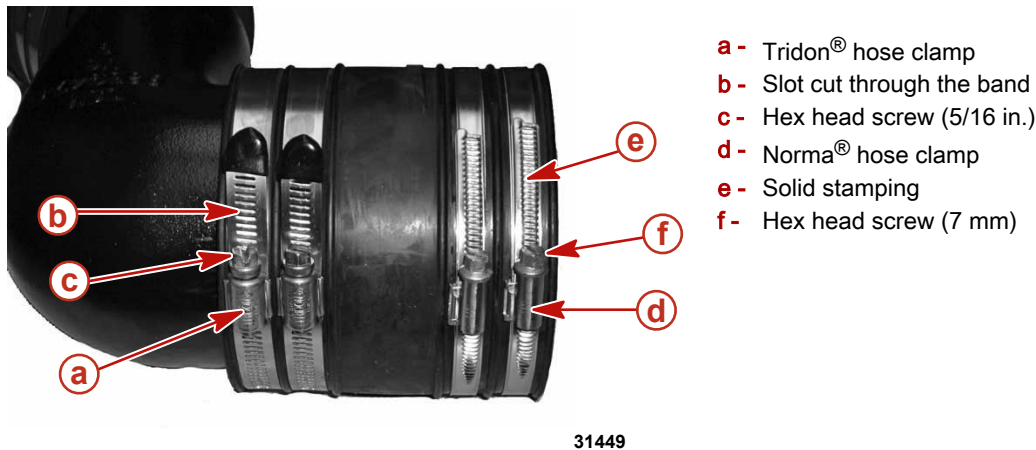
51215

Exhaust System Components—Sterndrive

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Exhaust tube			
2	8	Tridon® hose clamp	4–4.7	35–42	–
		Norma® hose clamp	2.9–3.4	26–30	–
3	1	Intermediate elbow kit, nonriser			
	1	Intermediate elbow kit, 2-in. riser			
	1	Intermediate elbow kit, 4-in. riser			
	1	Intermediate elbow kit, 6-in. riser			
4	8	Tridon® hose clamp	4–4.7	35–42	–
		Norma® hose clamp	2.9–3.4	26–30	–
5	2	Exhaust tube			
6	1	Exhaust pipe			
7	2	Water shutter assembly			
8	4	Grommet			
9	4	Screw	34	–	25
10	4	Lockwasher			
11	1	Through-the-transom exhaust plate kit			
12	4	Screw	34	–	25
13	4	Lockwasher			

Hose Clamp Identification

IMPORTANT: Two different types of hose clamps may be used in various locations on Mercury MerCruiser power packages. The hose clamps differ in appearance and have different torque specifications.



Tridon® Hose Clamp

The Tridon® hose clamp uses a worm screw with 5/16 in. hex head to engage slots cut through the band.

Description	Nm	lb-in.	lb-ft
Tridon® hose clamp	4-4.7	35-42	

Norma® Hose Clamp

The Norma® hose clamp is solid-stamped to eliminate cuts through the band. The hex head size of the screw is 7 mm.

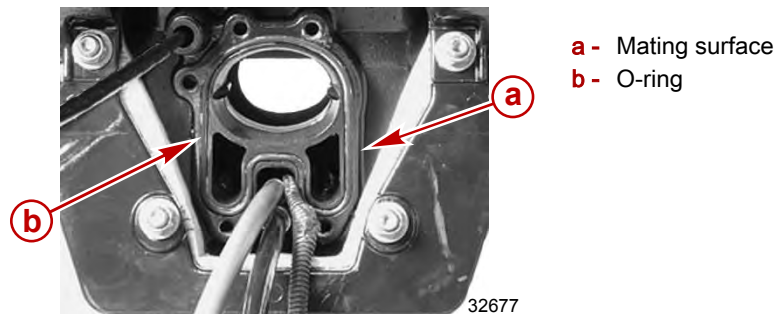
Description	Nm	lb-in.	lb-ft
Norma® hose clamp	2.9-3.4	26-30	

Component Replacement

Through-the-Propeller Exhaust

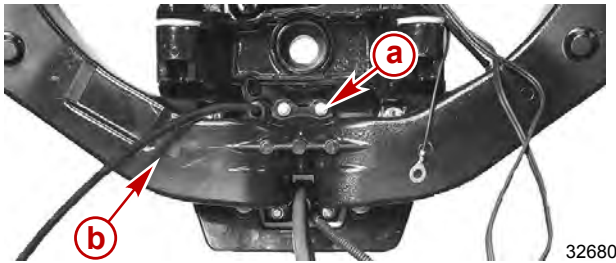
IMPORTANT: The exhaust pipe and the gimbal housing mating surface must be clean and free of nicks and scratches, and the O-ring must be properly seated in the groove or water may leak into the boat.

1. Inspect and clean the mating surfaces on the gimbal housing.
2. Inspect the O-ring. The O-ring must remain in the groove.



3. Inspect and clean the mating surfaces on the exhaust pipe.

4. Install the exhaust pipe assembly using the four screws and lock-washers. Tighten the screws to specification.



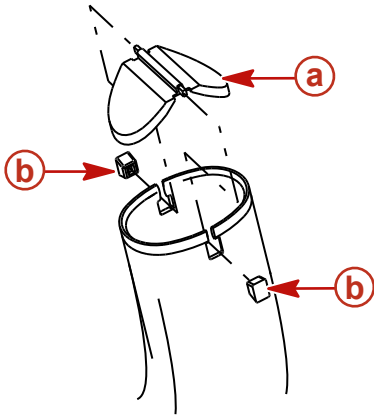
- a - Exhaust Y-pipe screw (4)
- b - Exhaust Y-pipe

Description	Nm	lb-in.	lb-ft
Exhaust Y-pipe screw	34		25

Water Shutter Replacement

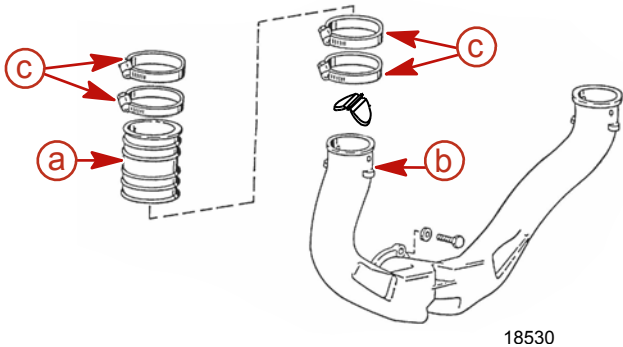
IMPORTANT: Exhaust system connections to components other than those supplied by Mercury Marine must use two stainless steel clamps that are at least 13 mm (½ in.) wide at each joint.

1. Remove and retain the intermediate exhaust pipe from the Y-pipe.
2. Remove and discard the water shutter and grommets from the Y-pipe.
3. Install the water shutter into the Y-pipe. Ensure that the water shutter is seated into the rubber grommets.



- a - Water shutter
- b - Rubber grommet

4. Install the exhaust tube and the intermediate exhaust pipe onto the exhaust Y-pipe and secure with hose clamps. Tighten the hose clamps to specification.



- a - Exhaust tube
- b - Hose clamps
- c - Exhaust Y-pipe

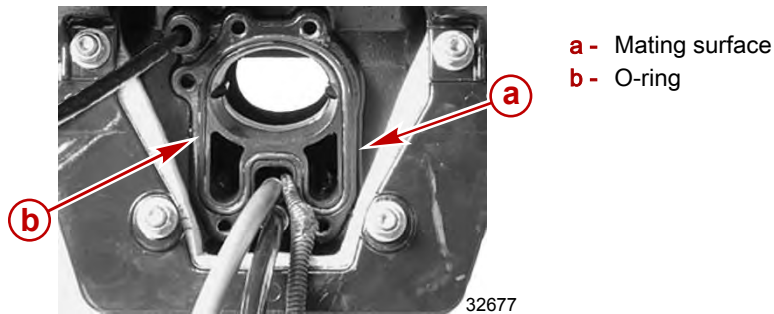
Description	Nm	lb-in.	lb-ft
Tridon® hose clamp (exhaust tube)	4-4.7	35-42	
Norma® hose clamp (exhaust tube)	2.9-3.4	26-30	

Through-the-Transom Exhaust

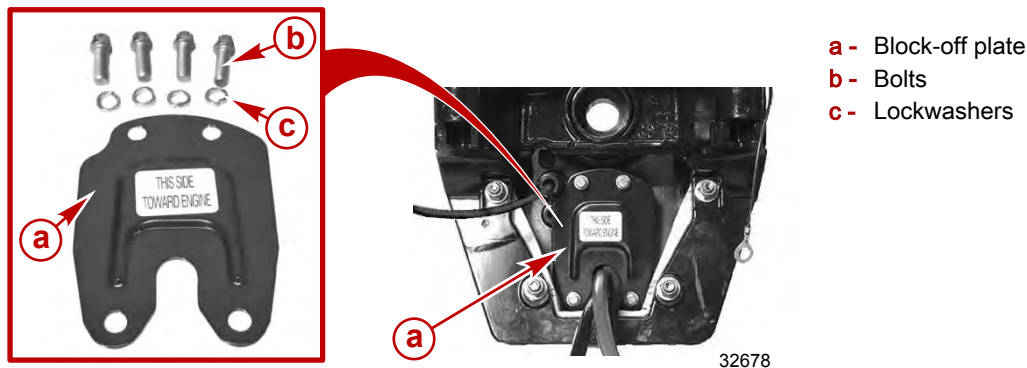
IMPORTANT: The block-off plate and the gimbal housing mating surface must be clean and free of nicks and scratches, and the O-ring must be properly seated in the groove or water may leak into boat.

IMPORTANT: A block-off plate must be installed when using through-the-transom exhaust or below swim platform kits.

1. Inspect and clean the mating surfaces on the gimbal housing.
2. Inspect the O-ring. The O-ring must remain in the groove.



3. Inspect and clean the mating surfaces on the block-off plate.
4. Install the block-off plate assembly using the four screws and lockwashers. Tighten the screws to specification.

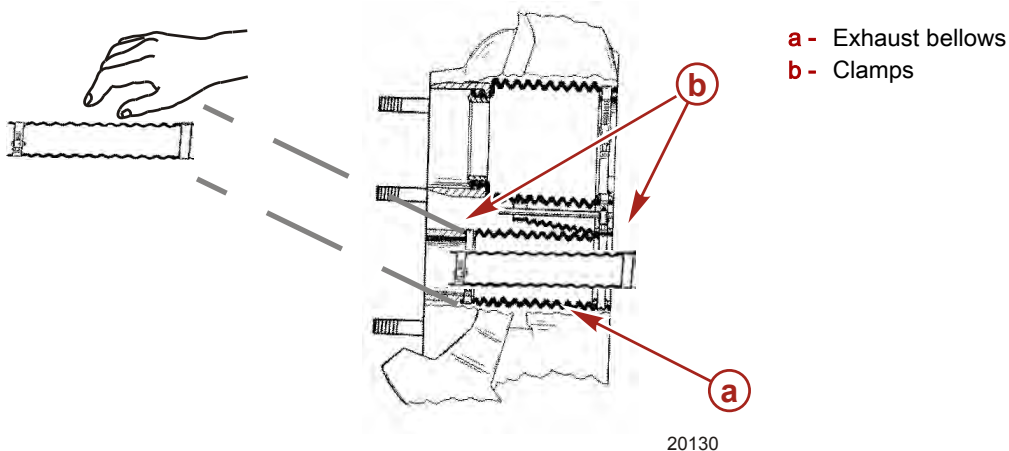


Description	Nm	lb-in.	lb-ft
Exhaust block-off plate bolts	34		25

Optional Exhaust Tube Installation

IMPORTANT: Remove the exhaust bellows and install an exhaust tube on the transom assembly when:

- The 377 MAG engine package is equipped with a Bravo sterndrive and through-the-propeller exhaust.
 - The exhaust system can be switched to either through-the-propeller or through-the-transom exhaust.
1. Remove and discard the clamps and exhaust bellows from the gimbal housing.

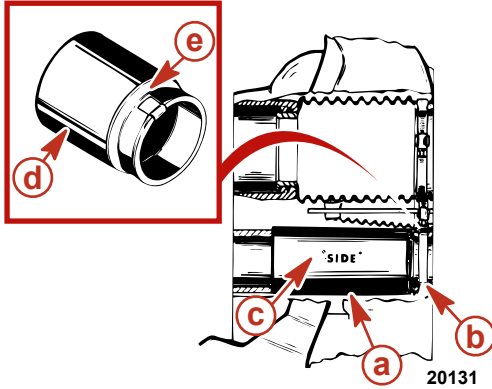


IMPORTANT: Failure to install the grounding clip may lead to corrosion of the exhaust tube, damaging it. Always install the grounding clip.

2. Install the grounding clip on the exhaust tube.
3. Position the tube so that the "SIDE" markings on the tube are facing the right and left sides.

NOTE: Bellows adhesive is not used when installing an exhaust tube.

4. Install the clamp.
5. Tighten the clamp securely.



- a - Exhaust tube
- b - Clamp
- c - "SIDE" marking
- d - Exhaust tube
- e - Grounding clip

Notes:

Steering Systems

Section 8A - Power-Assisted Steering Pump and Related Components

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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power-assisted steering pump shaft	92-858074K01
		Power-assisted steering system	

Special Tools

Power Steering Pump Pulley Remover	SPX J-21239
 25952	Removes the pulley on the DHB power steering pumps and water pumps with smaller shafts.

Pulley Pusher	91-93656A1
 10047	Installs the pulley onto the power steering pump.

Power Steering Test Gauge Kit	91-38053A05
 10804	Tests the power steering system pressure.

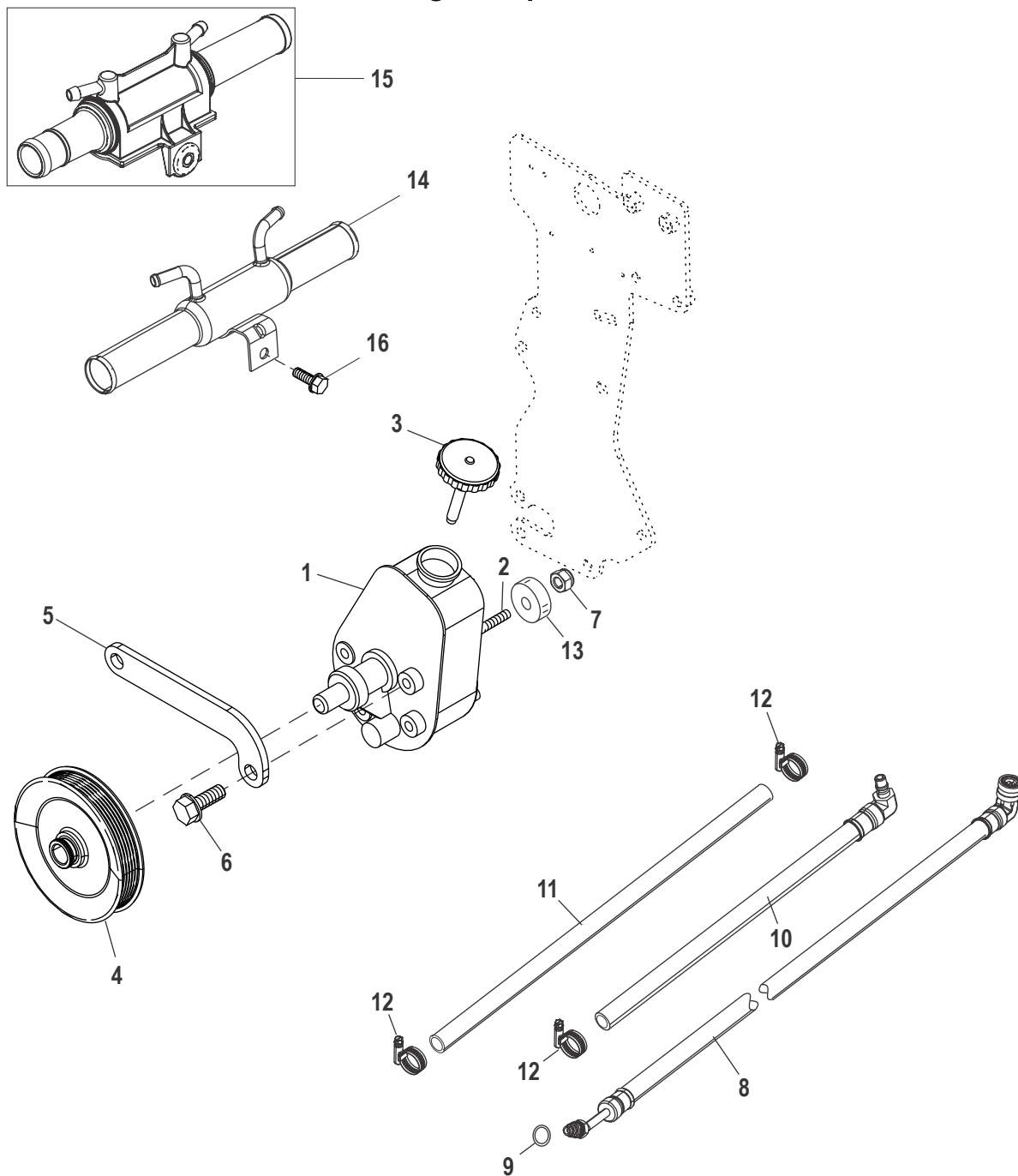
Parts List

NOTE: Obtain from a local GM automotive dealer.

Description	Qty.	Part Number
Power-Assisted Steering Pump Seal kit	1	5688044

Notes:

4.3L TKS Power-Assisted Steering Pump

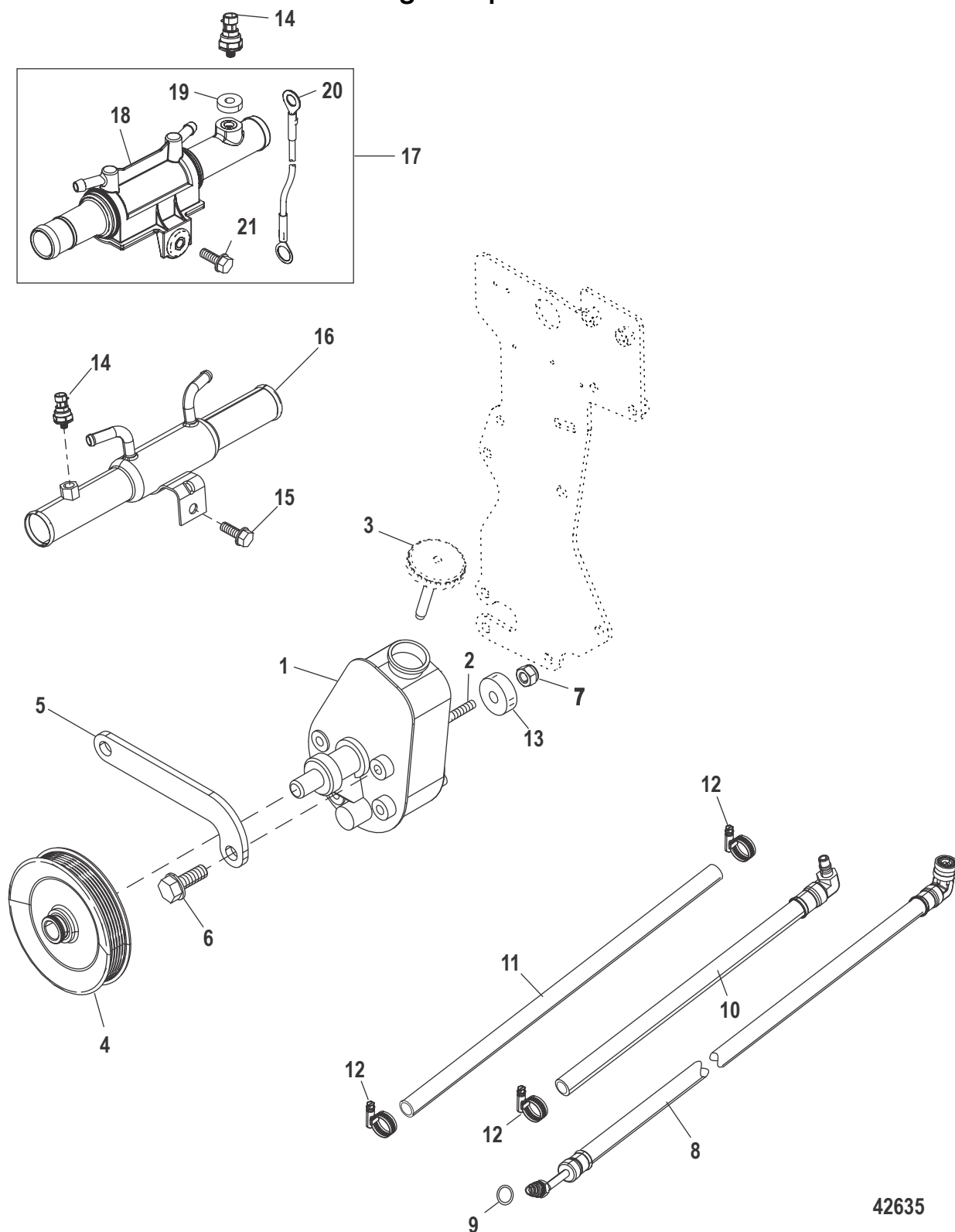


42316

4.3L TKS Power-Assisted Steering Pump

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Power-assisted steering pump assembly			
2	2	Stud (M10)			
3	1	Cap			
4	1	Pulley			
5	1	Brace			
6	2	Screw (M10 x 20)	41	–	30
7	2	Nut (M10)			
8	1	Pressure hose with female quick-connect fitting	31	–	23
9	1	O-ring (0.301 x 0.064)			
10	1	Hose with male quick-connect fitting			
11	1	Hose			
12	3	Hose clamp			
13	1	Spacer (0.750 x 0.250)			
14	1	Power steering cooler (metal)			
15	1	Power steering cooler (composite)			
16	1	Screw (0.375-18 x 0.875) (metal cooler)			
16	1	Screw (0.312 x 1.25) (composite cooler)			

4.3L MPI Power-Assisted Steering Pump



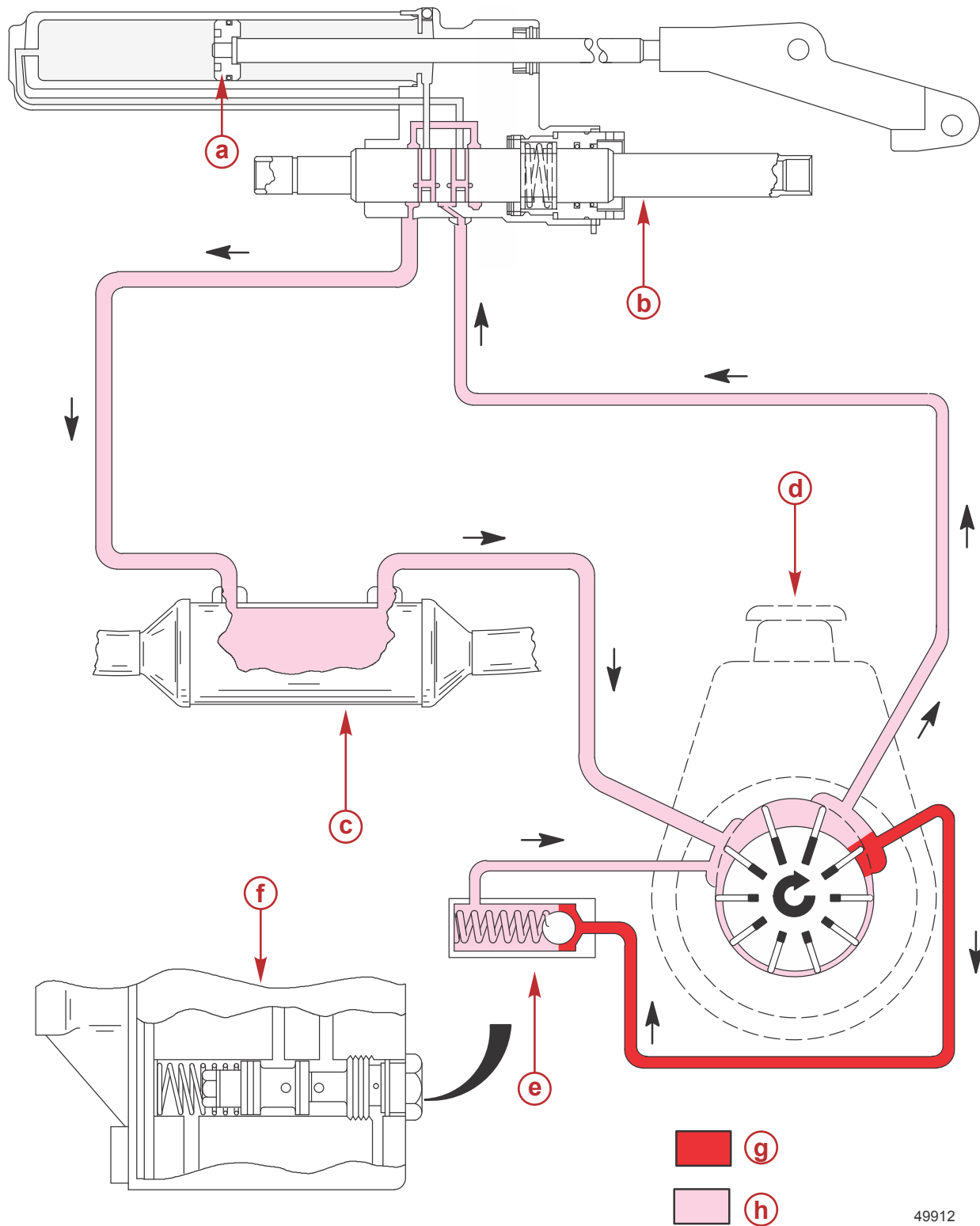
42635

4.3L MPI Power-Assisted Steering Pump

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Power-assisted steering pump assembly			
2	2	Stud (M10)			
3	1	Cap			
4	1	Pulley			
5	1	Brace			
6	2	Screw (M10 x 20)	41	–	30
7	2	Nut (M10)			
8	1	Pressure hose with female quick-connect fitting	31	–	23
8	1	Hose with female quick-connect fitting (jackshaft models)	31	–	23
9	1	O-ring (0.301 x 0.064)			
10	1	Hose with male quick-connect fitting			
10	1	Hose with male quick-connect fitting (jackshaft models)			
11	1	Hose (pump to cooler)			
12	3	Hose clamp			
13	1	Spacer (0.750 x 0.250)			
14	1	Sensor			
15	1	Screw (0.375-18 x 0.875)			
16	1	Power steering cooler (metal)			
17	1	Power steering cooler assembly (composite)			
18	1	Power steering cooler (composite)			
19	1	Spacer			
20	1	Harness ground			
21	1	Screw (0.312 x 1.25)			

Hydraulic Diagrams

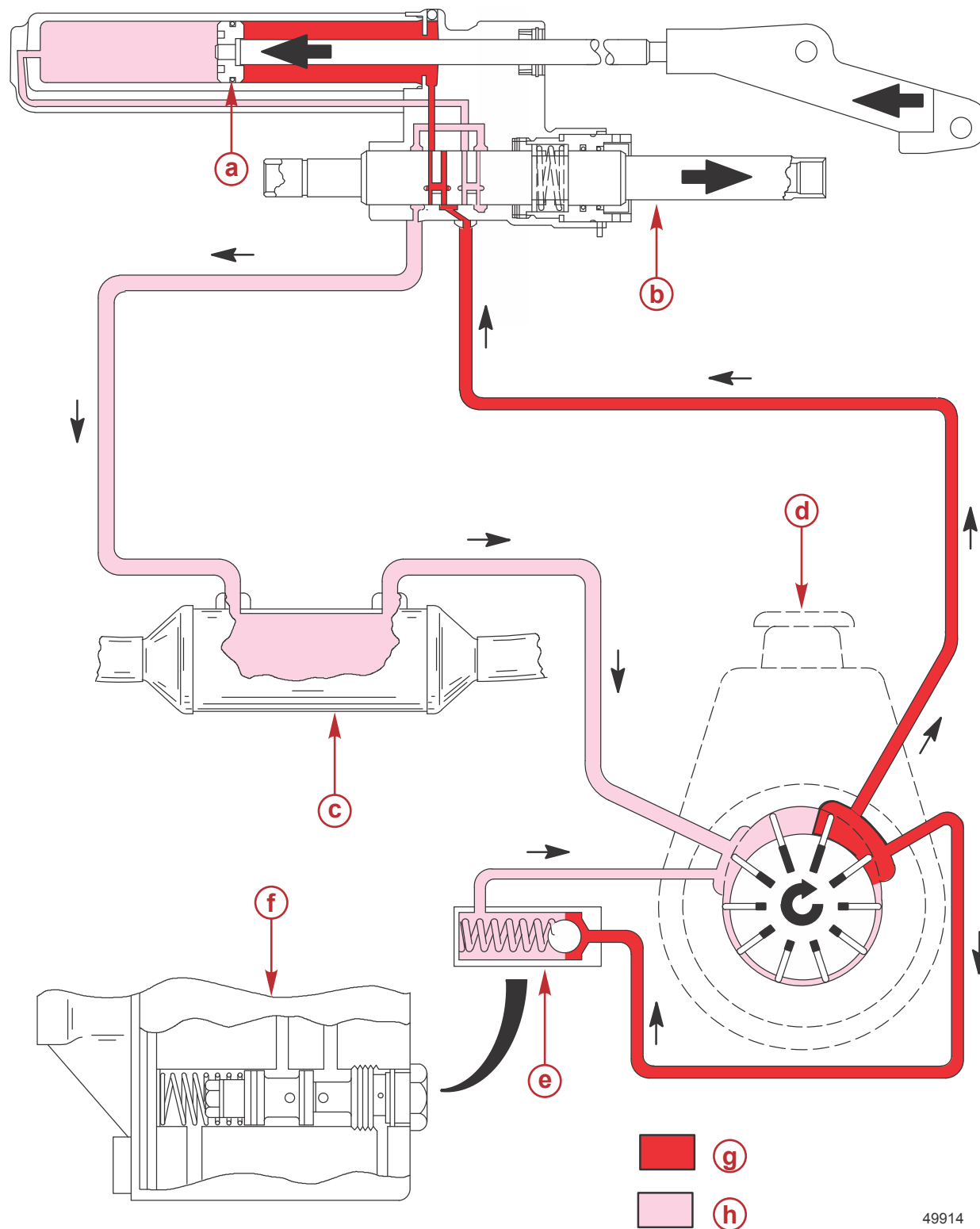
Neutral



The image represents the view from the inside of the boat looking at the transom

- a** - Piston
- b** - Control valve
- c** - Power steering fluid cooler
- d** - Pump
- e** - Relief valve (inside of the pump housing)
- f** - Pump housing
- g** - High pressure
- h** - Low pressure

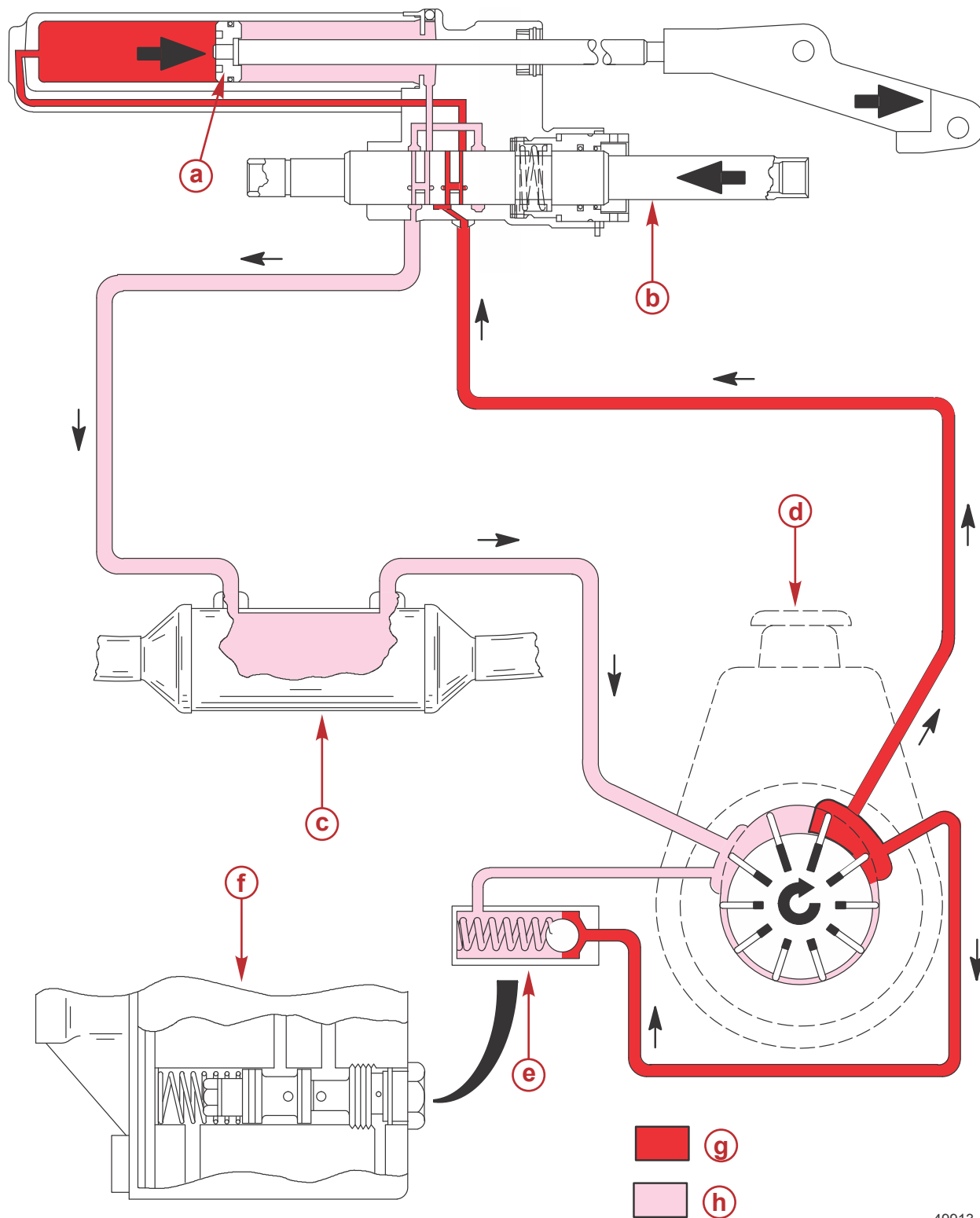
Left Turn



The image represents the view from the inside of the boat looking at the transom

- a** - Piston
- b** - Control valve
- c** - Power steering fluid cooler
- d** - Pump
- e** - Relief valve (inside of the pump housing)
- f** - Pump housing
- g** - High pressure
- h** - Low pressure

Right Turn



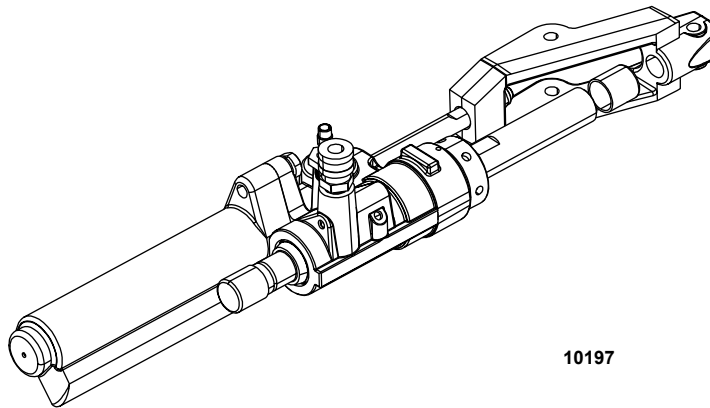
The image represents the view from the inside of the boat looking at the transom

- a - Piston
- b - Control valve
- c - Power steering fluid cooler
- d - Pump
- e - Relief valve (inside of the pump housing)
- f - Pump housing
- g - High pressure
- h - Low pressure

Description

Control Valve

The control valve is not serviceable and must be replaced as a complete assembly.



10197

Power-Assisted Steering Pump

The power-assisted steering pump is not serviceable and must be replaced as a complete assembly.

Power-Assisted Steering Pump Pulley

Power-Assisted Steering Pump Pulley—Removal

NOTE: The power-assisted steering pump pulley may be removed and installed while the power-assisted steering pump assembly remains mounted to the engine.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

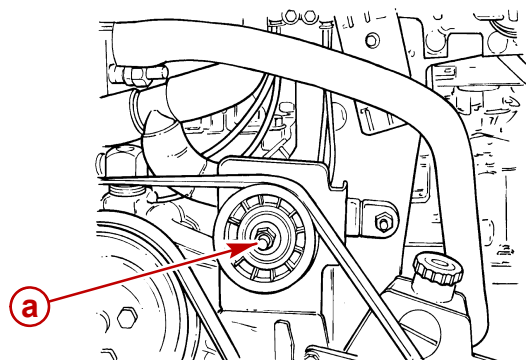
⚠ CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

1. Disconnect both battery cables from the battery.

Power-Assisted Steering Pump and Related Components

- Loosen the adjusting nut, and remove the serpentine belt from the power-assisted steering pulley.



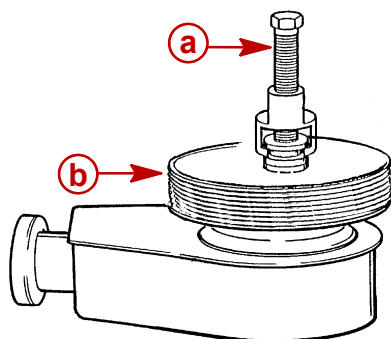
a - Adjusting nut

26721

- Install the pulley removal tool on the end of the power-assisted steering pulley and the shaft.

Power Steering Pump Pulley Remover	SPX J-21239
------------------------------------	-------------

- While holding the pulley removal tool with a suitable wrench, turn the threaded bolt until the power-assisted steering pump pulley is removed.



Power-assisted steering pump assembly removed from engine to show clarity

a - Typical pulley removal tool

b - Power-assisted steering pump pulley

26722

Power-Assisted Steering Pump Pulley—Installation

Install the power-assisted steering pump pulley using the pulley pusher.

- Thread the stud from the pulley pusher completely into the power-assisted steering pump shaft.

Pulley Pusher	91-93656A1
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- Lubricate the power-assisted steering pump shaft with power trim and steering fluid.

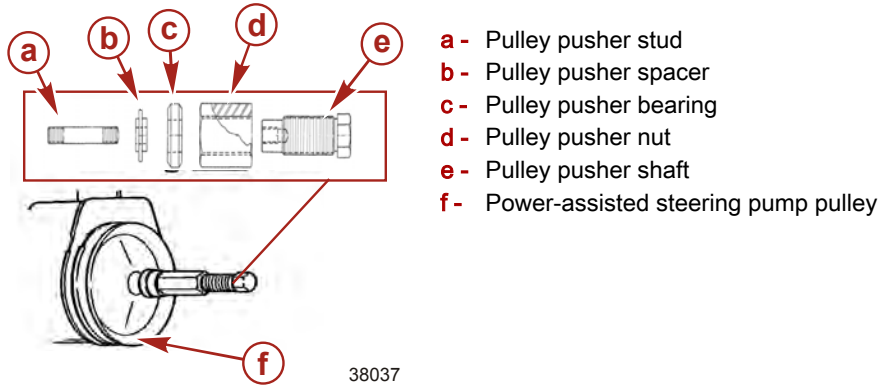
Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power-assisted steering pump shaft	92-858074K01

- Place the power-assisted steering pulley on the power-assisted steering pump shaft.
- Place the spacer on the pulley.
- Place the spacer and the bearing over the pulley pusher stud so that the spacer is against the pulley.
- Thread the pulley pusher nut onto the pulley pusher shaft.

NOTE: The spacer is designed to keep the bearing centered on the tool as well as press the pulley flush with the end of the shaft.

- Thread the pulley pusher shaft and nut onto the pulley pusher stud (threaded into the power-assisted steering pump shaft).

8. Turn the pulley pusher nut until the face of the power-assisted steering pulley is even with the edge of the power-assisted steering shaft.



Power-Assisted Steering Pump Assembly

Steering Pump Assembly Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ CAUTION

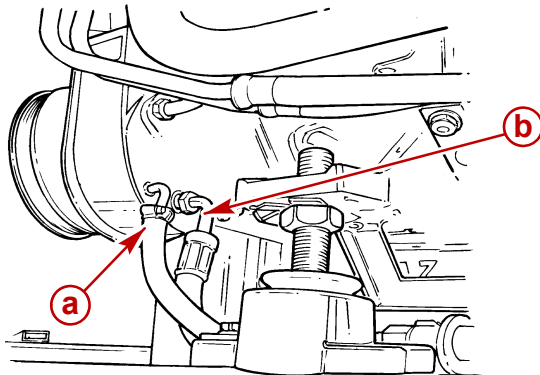
Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

1. Disconnect both battery cables from the battery. Be certain to disconnect the negative (-) cable first.
2. Remove the serpentine drive belt from the power-assisted steering pulley.

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

3. Drain the fluid from the steering pump assembly:
 - a. Allow the fluid to cool. Remove the power-assisted steering pump cap and dipstick.
 - b. Remove the high-pressure hose and the return hose from the power-assisted steering pump.
 - c. Drain the fluid into a suitable container. Dispose of the fluid according to local regulations.

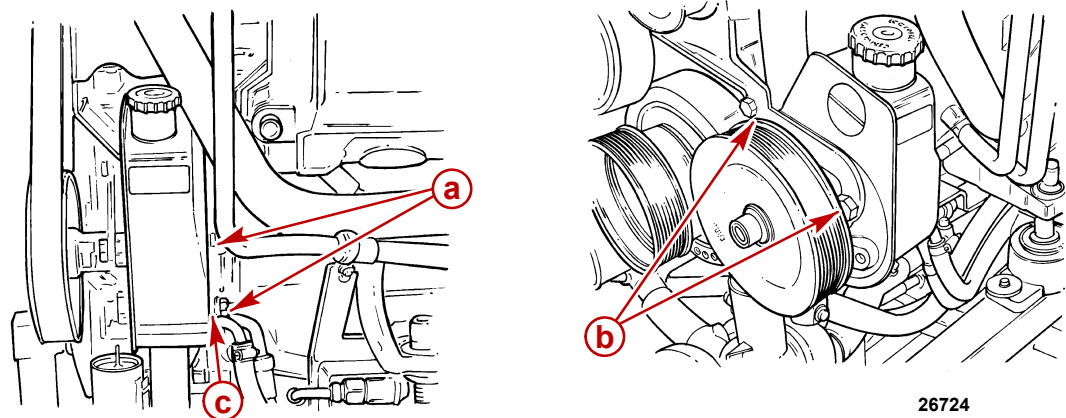


26723

Power-assisted steering pump assembly

- a - Return hose
- b - High-pressure hose

4. Remove the bolts and nuts from the power-assisted steering pump and mounting brackets.



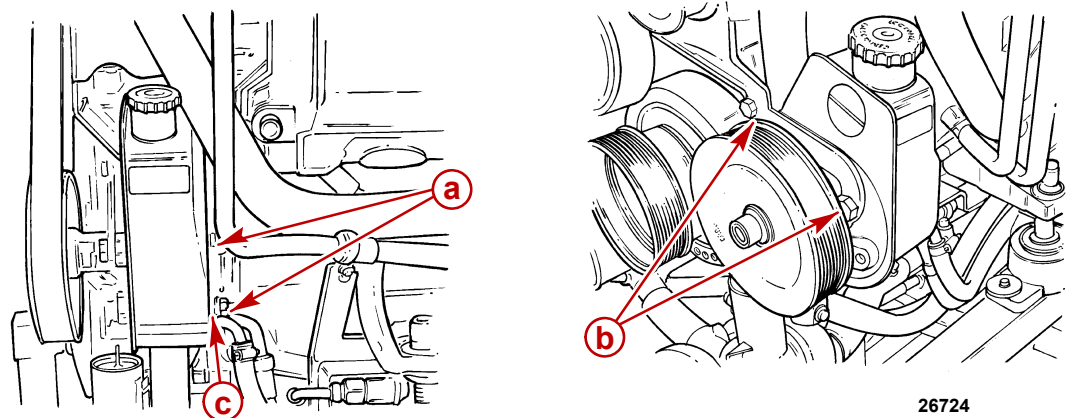
- a - Nuts
- b - Bolts
- c - Spacer (if equipped)

5. Remove the power-assisted steering pump from the mounting brackets.
6. If equipped, remove the spacer from the lower mounting stud.

Steering Pump Assembly Installation

IMPORTANT: Do not cross-thread or overtighten the hose fittings.

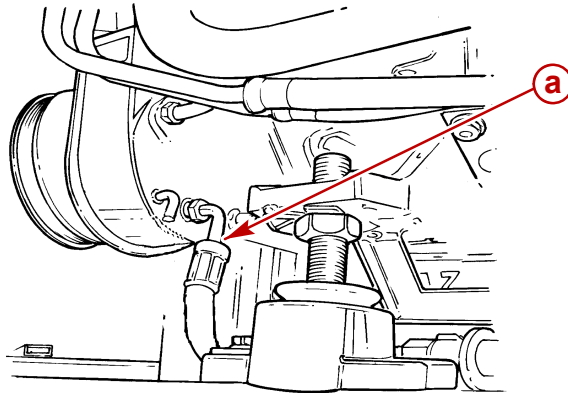
1. If equipped, place the spacer on the lower mounting stud.
2. Place the power-assisted steering pump onto the mounting brackets.
3. Install and tighten the bolts and nuts to the specified torque.



- a - Nuts
- b - Bolts
- c - Spacer (if equipped)

Description	Nm	lb-in.	lb-ft
Power-assisted steering pump fasteners	41	–	30

- Install the high-pressure hose fitting and new O-ring onto the steering pump assembly. Tighten the hose fitting to the specified torque.

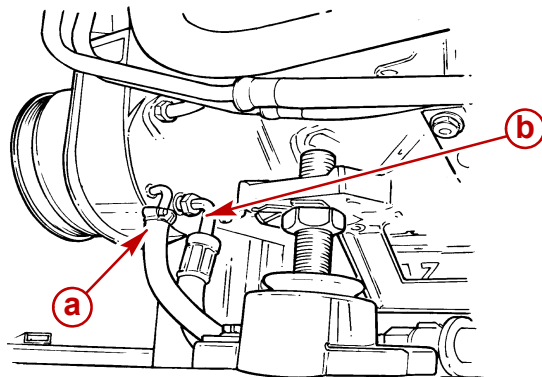


a - High-pressure hose and fitting

26726

Description	Nm	lb-in.	lb-ft
Power-assisted steering hose fittings	31	–	23

- Connect the return hose to the steering pump assembly and secure it with a hose clamp.



a - Return hose
b - High-pressure hose

26723

Replacing the Belt and Adjusting Tension

To replace the drive belt or to adjust the tension, refer to **Serpentine Drive Belt** in **Section 1C**.

Power-Assisted Steering Fluid

Filling and Bleeding

IMPORTANT: Fill the power-assisted steering system exactly as explained in the following procedure to ensure that all air is bled from the system. Failure to remove the air may cause foam during operation and discharge from the pump reservoir. Foamy fluid may cause the power-assisted steering system to become spongy, resulting in poor boat control.

- Using the steering wheel, position the sterndrive so that it is in the straight ahead position.
- Stop the engine.
- Remove the cap and dipstick from the power-assisted steering pump.
- Add approved fluid to bring the level up to the "FULL COLD" mark on the dipstick.

IMPORTANT: Use only Power Trim and Steering Fluid in the power-assisted steering system.

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

- Install the cap and dipstick. Tighten the cap securely.

NOTICE

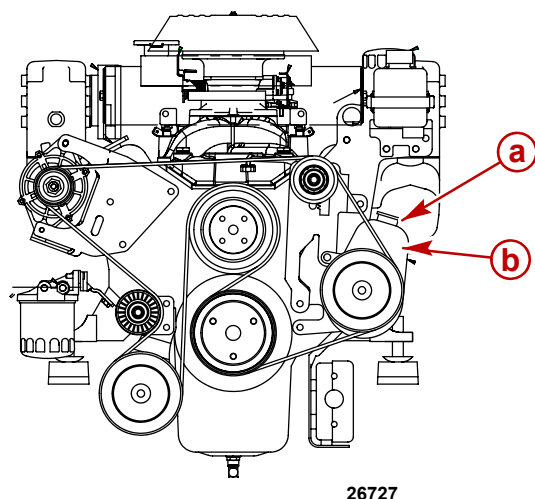
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

6. Start the engine and operate it at fast idle (1000–1500 RPM) until it reaches normal operating temperature. During this time, turn the steering wheel fully back and forth several times.
7. Using the steering wheel, position the sterndrive so that it is pointed straight ahead.
8. Stop the engine.
9. Remove the cap and dipstick from the reservoir.
10. Allow any foam in the pump reservoir to disperse.
IMPORTANT: The sterndrive must be in the straight ahead position and steering fluid must be hot for an accurate reading of the fluid level.
11. Check the fluid level and add fluid as required to bring the level up to the "FULL HOT" mark on the dipstick. Do not overfill.
12. Reinstall the cap and dipstick. Tighten the cap securely.
13. If the fluid is still foamy, repeat steps 6 through 12 until the fluid does not foam and the level remains constant.

Checking Fluid Level

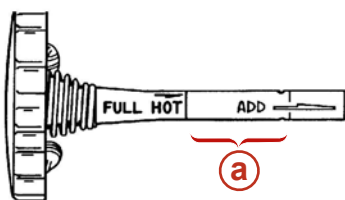
Engine Warm

1. Stop the engine. Center the sterndrive.
2. Remove the cap and dipstick from the power-assisted steering pump and note the fluid level.



- a - Cap and dipstick
b - Power-assisted steering pump

3. The level should be between the "FULL HOT" mark and the "ADD" mark on the dipstick.



- a - Proper fluid level with engine warm

4. If the level is below the "ADD" mark, but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill opening to bring the level up to the "FULL HOT" mark on the dipstick. Do not overfill.

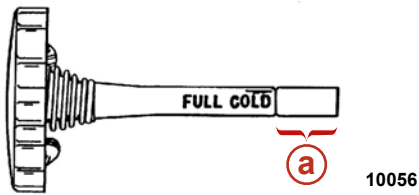
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

5. If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct it.

Engine Cold

1. With the engine stopped, center the sterndrive.

2. Remove the cap and dipstick from the power-assisted steering pump and note the fluid level.
3. The level should be between the "FULL COLD" mark and the bottom of the dipstick.



a - Proper fluid level range with the engine cold

4. If the level is below the bottom of the dipstick, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the "FULL COLD" mark on the dipstick. Do not overfill.
5. If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find and correct the cause.

Power-Assisted Steering Hoses

IMPORTANT: Make the hydraulic connections as quickly as possible to prevent fluid from leaking.

IMPORTANT: Do not cross-thread or overtighten the hose fittings.

High-Pressure Hose (Pump to Control Valve)

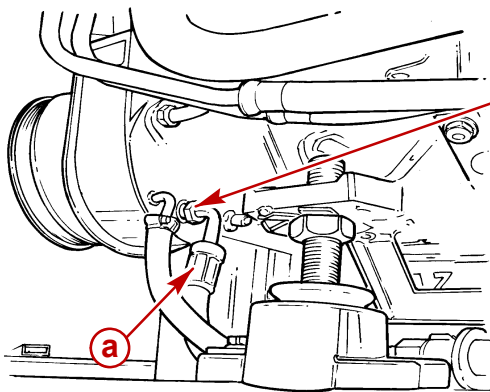
Removal

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: Catch the fluid that drains from the pump and the hoses in a suitable container. Dispose of fluids as required.

1. Note the position and the routing of the steering pressure hose before removal.
2. Remove the high-pressure hose and the O-ring from the power-assisted steering pump assembly.

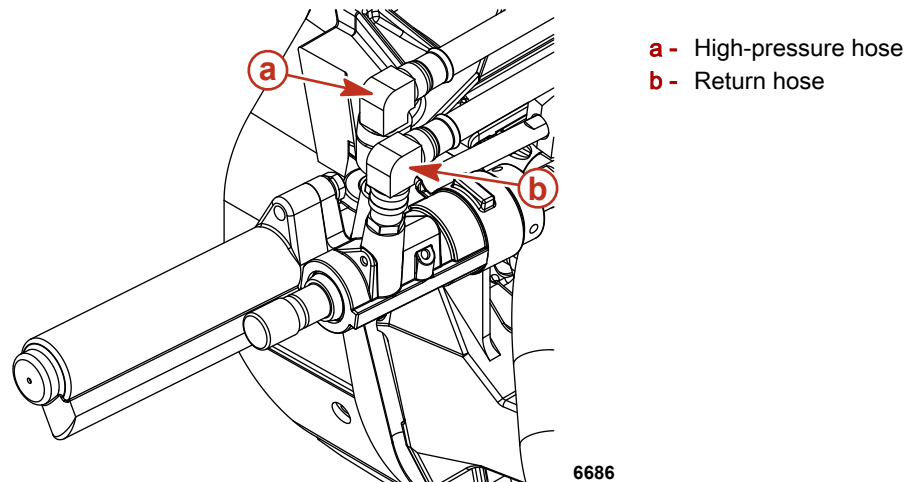


a - High-pressure hose

b - Hose fitting (O-ring not shown)

26728

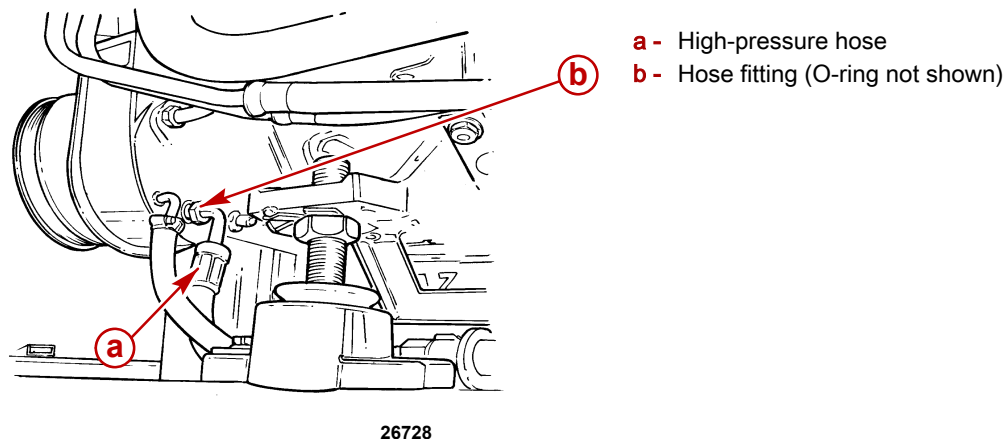
- 3. Disconnect the high-pressure hose from the quick-connect fitting on the control valve at the transom.



Installation

IMPORTANT: Route the hoses as shown below to prevent kinks, which can damage the hoses or fittings.
IMPORTANT: Do not cross-thread or overtighten the hose fittings.

- 1. Route the high-pressure hose into the same position as prior to removal.
- 2. Install a new O-ring in the high-pressure hose fitting, and install the fitting onto the power-assisted steering pump assembly. Tighten the fitting to the specified torque.



Description	Nm	lb-in.	lb-ft
High-pressure hose fitting	31	–	23

- 3. Route the high-pressure hose to the control valve at the transom in the same position as prior to removal.
- 4. Install the high-pressure hose onto the quick-connect fitting on the control valve at the transom. Ensure that the quick-connect fitting snaps into place.
- 5. Fill and bleed the system. Refer to **Filling and Bleeding**.

Return Hose (Pump to Fluid Cooler)

Removal

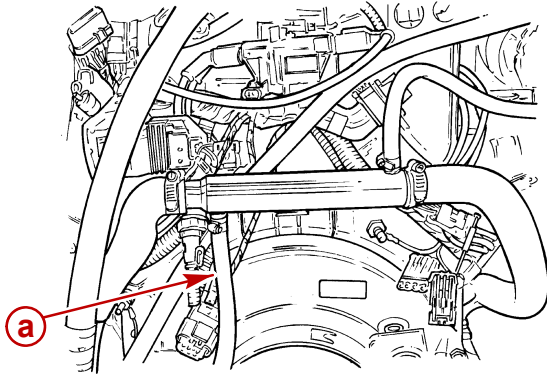
NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: Use a suitable container to catch the fluid that drains from the pump and hoses.

- 1. Note the routing of the return hose before removal.

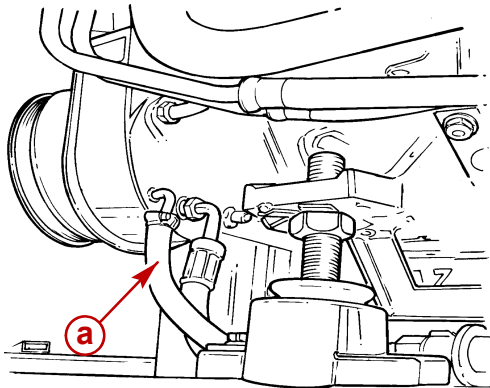
2. Loosen the hose clamp and remove the return hose from the fluid cooler.



a - Return hose

26730

3. Loosen the hose clamp and remove the return hose from the power-assisted steering pump assembly.



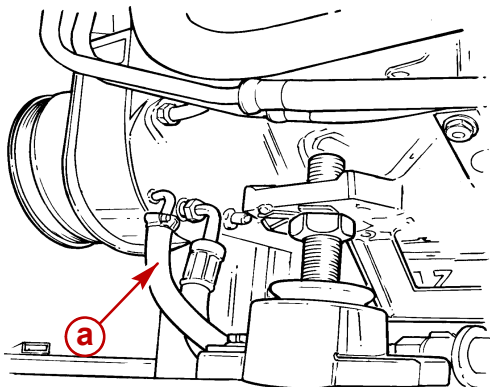
a - Return hose

26731

Installation

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.

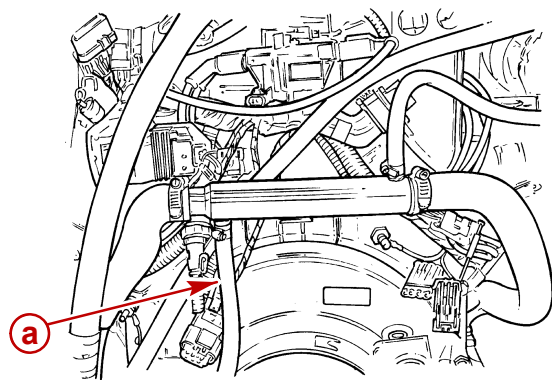
1. Route the return hose in the manner noted prior to removal.
2. Install the return hose onto the power-assisted steering pump assembly and secure it with hose clamps.



a - Return hose

26731

3. Install the return hose onto the fluid cooler and secure it with hose clamps.



a - Return hose

26730

4. Fill and bleed the system. Refer to **Filling and Bleeding**.

Return Hose (Control Valve to Fluid Cooler)

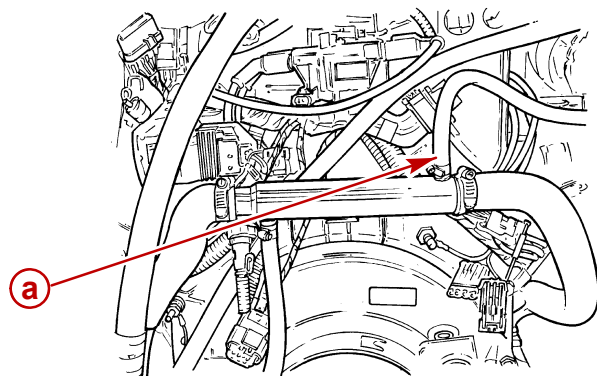
Removal

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: Use a suitable container to catch the fluid that drains from the pump and hoses.

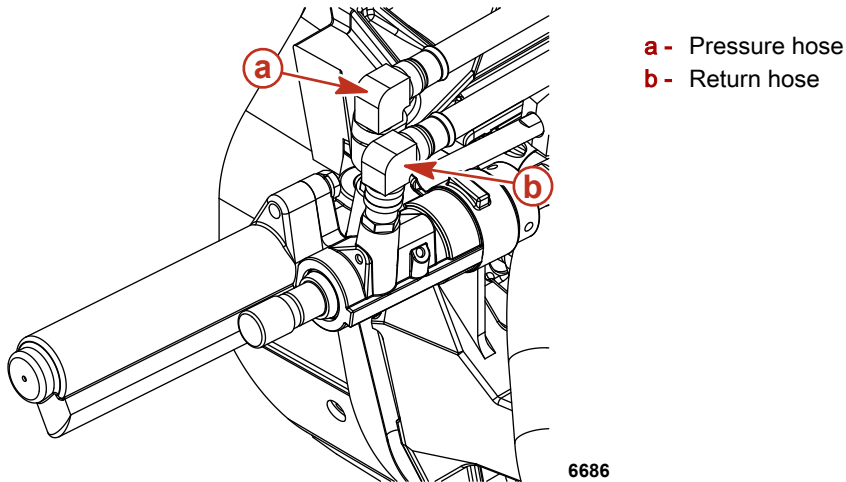
1. Note the position and routing of the return hose before removal.
2. Loosen the hose clamp and remove the return hose from the fluid cooler.



a - Return hose and hose clamp

26732

3. Disconnect the return hose from the control valve quick-connect fitting located at the transom.

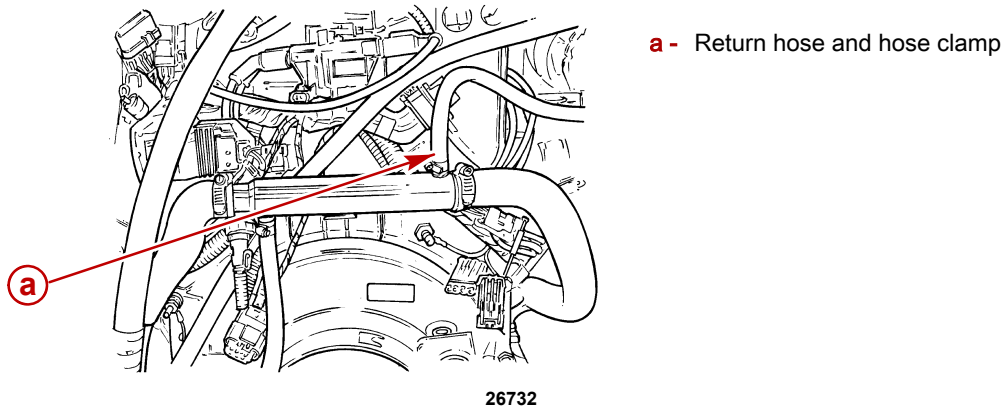


4. Remove the return hose.

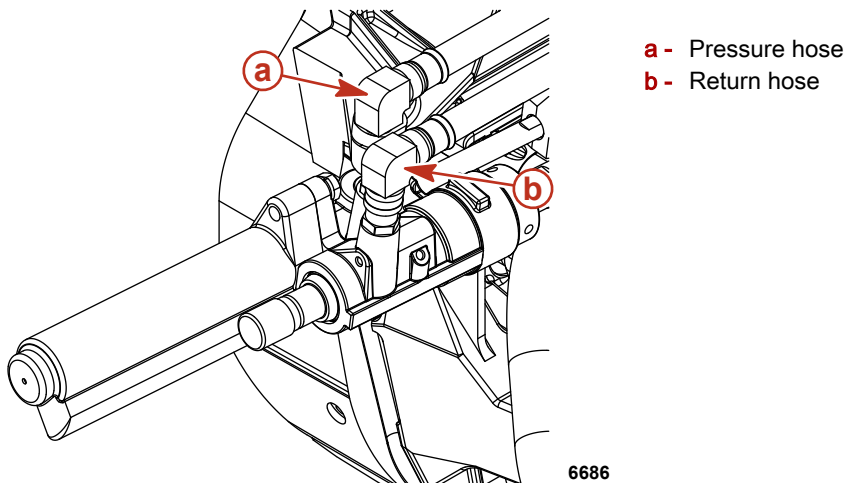
Installation

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.
IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

1. Route the return hose in the manner noted prior to removal.
2. Install the return hose onto the fluid cooler, and secure it with hose clamps.



3. Install the return hose onto the control valve quick-connect fitting located at the transom.



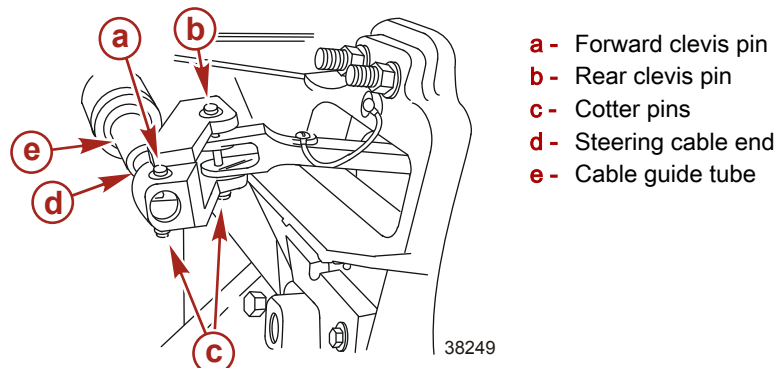
4. Fill and bleed the system. Refer to **Filling and Bleeding**.

Power-Assisted Steering System Tests

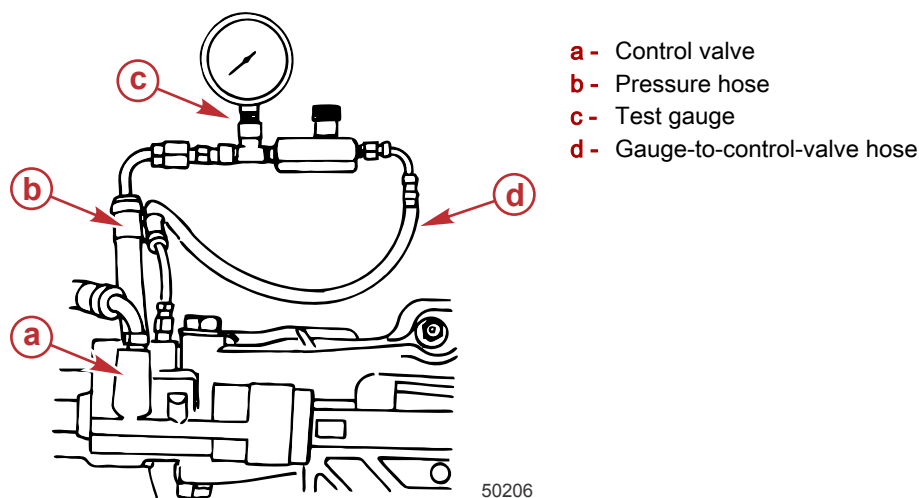
Power-Assisted Steering System Pressure Test

These test procedures are arranged so that a defective component can be detected through the process of elimination. Perform these tests in order.

1. Remove the cotter pin and remove the front clevis pin.
2. Remove the cotter pin and remove the rear clevis pin.
3. Retract the steering cable into the cable guide tube.



4. Remove the high-pressure hose at the control valve, and install the test gauge between the hose and the control valve.



Power Steering Test Gauge Kit

91-38053A05

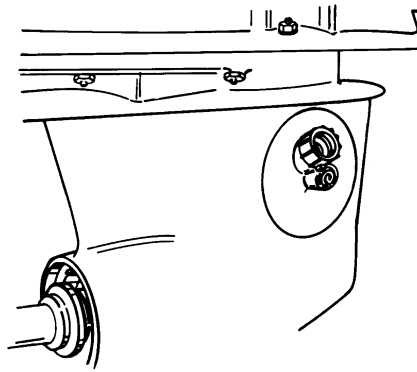
5. Completely open the valve on the power steering test gauge.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

6. If the boat is out of the water, connect a flushing device to the water inlet.

NOTE: For complete flush test device installation instructions, refer to **Sterndrive Water Pickups** in **Section 1C**.



26735

Standard Bravo shown

7. Start the engine and operate it at 1000–1500 RPM until it reaches normal operating temperature.
8. With the engine at idle speed, the test gauge reading should be 483–862 kPa (70–125 psi). If not, proceed as follows:
 - If it is lower than 483 kPa (70 psi), refer to **Pump Pressure Test**.
 - If it is higher than 862 kPa (125 psi), check for hose restrictions in the power-assisted steering system.

NOTICE

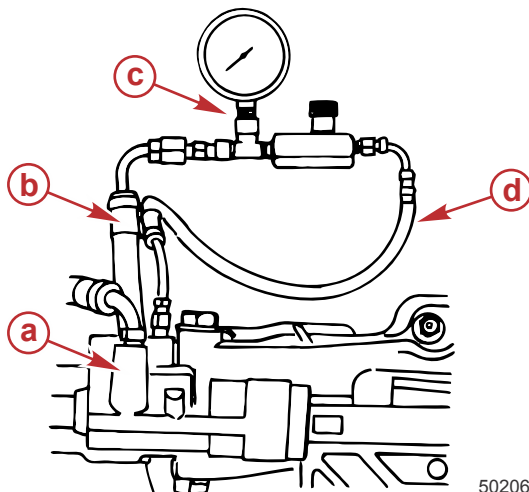
Excessive operation can cause product damage. Do not lug the pump at maximum pressure for more than 5 seconds.

9. Push in, then pull out on the steering cable. The gauge should show an instant increase in pressure when the block is pushed in both directions.
10. Push the steering cable in until the booster cylinder piston rod is fully retracted. With the piston rod in this position, push the steering cable in until a maximum pressure reading is obtained.
 - If the pressure is above 6897 kPa (1000 psi), the system pressure is good.
 - If the pressure is below 6897 kPa (1000 psi), conduct the **Pump Pressure Test**.

Pump Pressure Test

IMPORTANT: Excessive operation can cause product damage. Do not lug the pump at maximum pressure for more than five seconds.

1. Remove the high-pressure hose at the control valve, and install the test gauge between the hose and the control valve.



50206

- a - Control valve
- b - High-pressure hose
- c - Test gauge
- d - Gauge-to-control-valve hose

Power Steering Test Gauge Kit

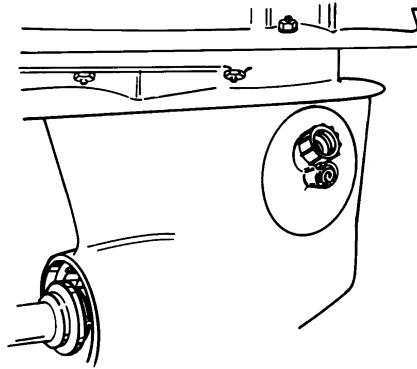
91-38053A05

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Power-Assisted Steering Pump and Related Components

2. If the boat is out of the water, connect a flush test device to the sterndrive. Refer to **Flushing the Power Package** in **Section 1C** for proper seawater supply procedures. The cooling system is full when water is discharged through the propeller.



26735

Bravo drive with flush test device

3. Start the engine and operate it at 1000–1500 RPM until it reaches normal operating temperature.
4. Close the test gauge valve briefly to obtain a maximum pressure reading.
5. Cycle the test gauge valve open and closed three times, and record the highest pressure reading attained during each cycle.
 - a. If the pressure readings are 7932–8621 kPa (1150–1250 psi) and are within 345 kPa (50 psi) of each other, then the pump is within specifications. If the pump is within specifications, but system pressure was low (as tested under the **Power-Assisted Steering System Pressure Test**), refer to the appropriate Mercury MerCruiser sterndrive service manual for additional information.
 - b. If the pressure readings are 7932–621 kPa (1150–1250 psi), but are not within 345 kPa (50 psi) of each other, then the steering pump flow control valve is sticking or the pump hydraulic system is dirty. Flush the pump with clean power steering fluid and recheck the pump pressure. If pump pressure is still not within specification, replace the power-assisted steering pump.
 - c. If pressure readings are constant, but below 6897 kPa (1000 psi), replace the power-assisted steering pump.

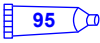
Steering Systems

Section 8B - Compact Hydraulic Steering

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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Bushings	92-802859A 1
		Upper and lower pivot bolt threads	
		Clevis pin and clevis	

Approved Hydraulic Steering Fluids

Description	Where used	Part Number
Hydraulic Helm Steering Fluid	Hydraulic hose end O-ring area	92-862014Q1

Important Information About Through-the-Transom Exhaust

IMPORTANT: This compact hydraulic steering system is not designed for use with through-the-transom exhaust systems.

Introduction

The system has a pressure-relief valve to protect against internal fluid pressure becoming too high for the individual system components. This valve minimizes the possibility of a total loss of steering.

The steering cylinder is an unbalanced cylinder: in any position the port and starboard cylinder chambers will have different volumes. This is important when setting the hydraulic fluid level, as outlined later.

The steering unit may not function properly if dirt or contaminants are introduced into the system.

IMPORTANT: Due to a small amount of internal hydraulic fluid transfer (slip), a master spoke or centered steering wheel cannot be maintained with a hydraulic steering system. For best results, use an equal-distance spoke steering wheel.

Steering Cylinder Removal

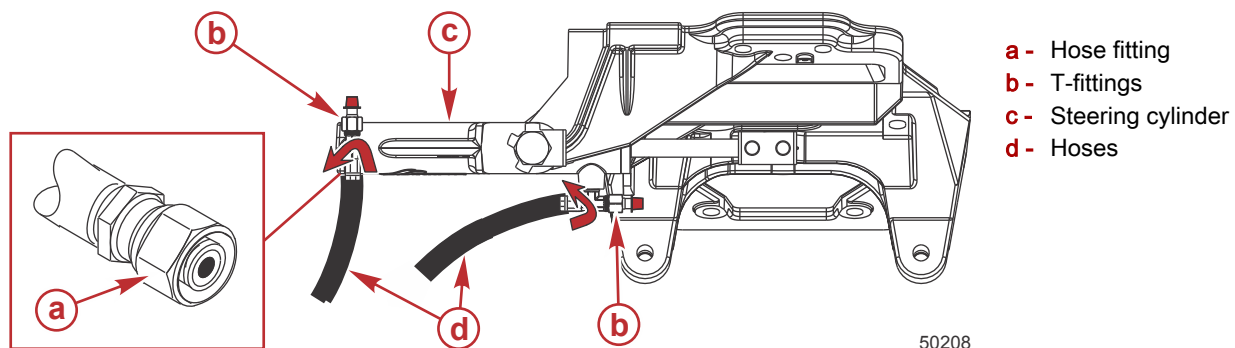
⚠ WARNING

Dirt or contaminants in the hydraulic steering system can damage the steering system's internal components. Damaged components can lead to serious injury or death due to loss of boat control. Do not allow dirt or contamination to enter the helm, lines, or cylinder of this steering system and perform all hydraulic inspections, service, or assembly procedures in a clean work area.

⚠ WARNING

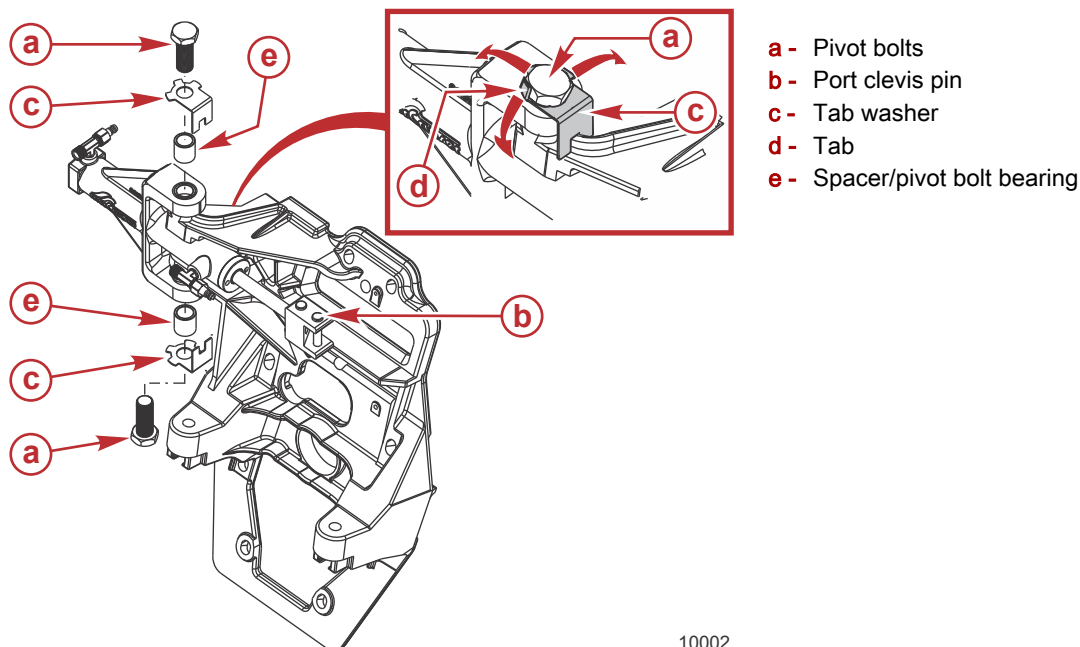
Stress on hose fittings or kinks in the hoses can damage hydraulic steering components, leading to serious injury or death due to loss of boat control. Extreme heat can lower the hoses' burst pressure or melt the hose. Route hydraulic hoses to avoid kinks, heat sources, or stress on the hose fittings.

- Loosen the hose fittings and remove the hoses from the T-fittings of the steering cylinder.
- Plug the ends of the hose to prevent fluid loss.



- Remove the cotter pin from the port clevis pin and remove the clevis pin.
- Bend the tabs of the tab washer away from the bolts.

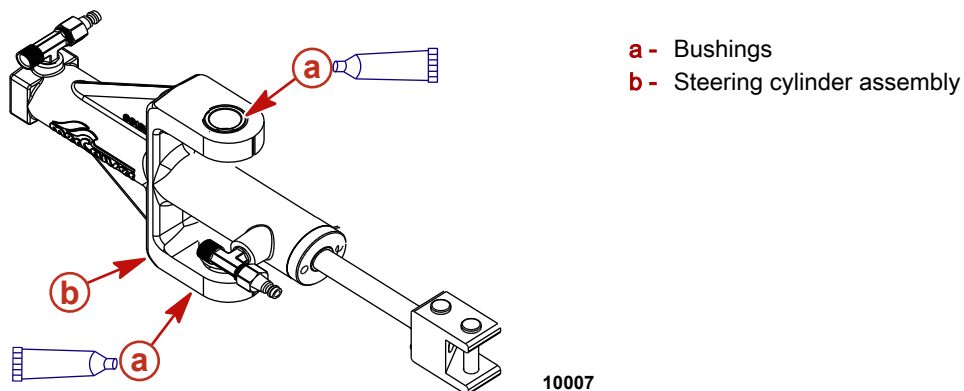
5. Remove the pivot bolts.



6. Remove the steering cylinder from the transom.

Steering Cylinder Installation

1. Verify that the bushings are clean.
2. Lubricate the bushings with 2-4-C with PTFE.



Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bushings	92-802859A 1

3. Remove the upper and lower pivot bolts, spacer, and tab washers. Ensure that the threads are well lubricated with 2-4-C with PTFE.

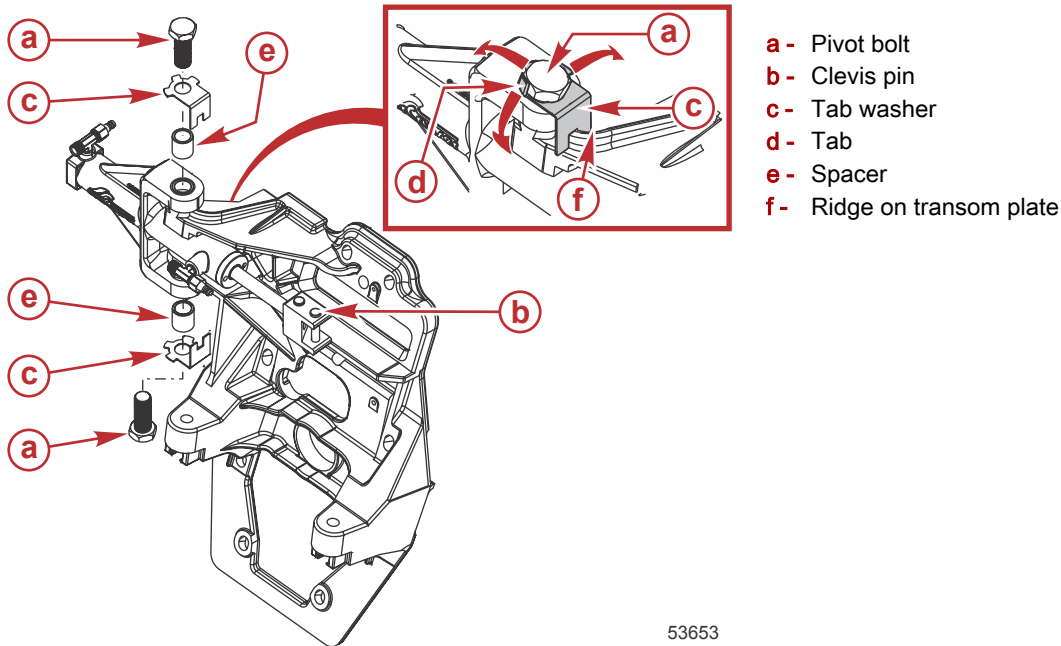
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Upper and lower pivot bolt threads	92-802859A 1

4. Install the steering cylinder assembly as follows:
- a. Position the steering cylinder assembly so that the upper and lower pivot bolts (with tab washers and spacers) can be threaded by hand into the transom plate.
 - b. Ensure that the tab washer tangs straddle the ridge on the transom plate (see the following illustration).
 - c. Ensure that the steering cylinder assembly pivots freely.
 - d. Tighten the pivot bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Pivot bolts	34	–	25

e. Bend the washer tabs against the corresponding flats of the bolt heads.

NOTE: It may be necessary to further tighten the pivot bolts to align the flats on the bolt with the tabs on the tab washer.



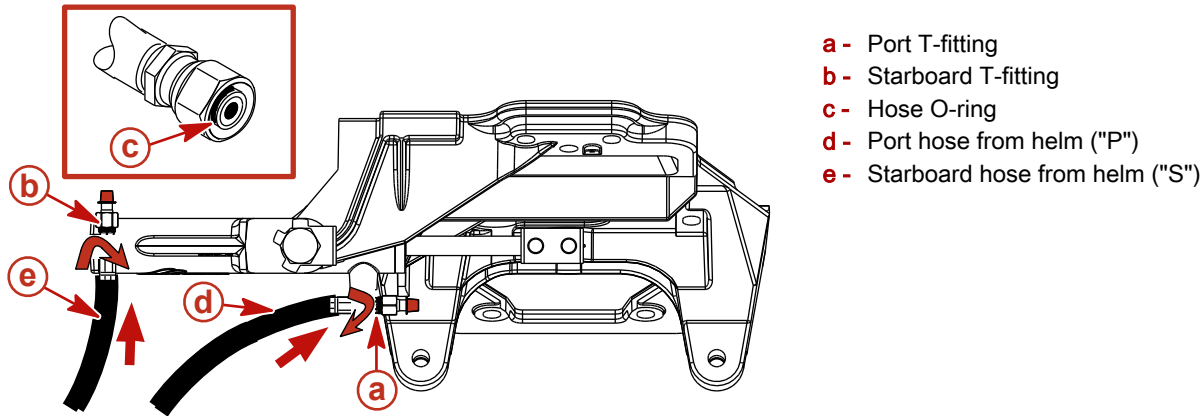
53653

IMPORTANT: Bleed and purge the system before connecting the clevis to the steering lever.

5. Connect the hoses to the steering cylinder as follows:
- a. Apply a small amount of clean hydraulic helm steering fluid to the hydraulic hose end O-ring area.

Description	Where used	Part Number
Hydraulic Helm Steering Fluid	Hydraulic hose end O-ring area	92-862014Q1

- b. Push the port and starboard hoses completely into the fittings.
- c. Hand-tighten the hose fittings.
- d. Tighten the hose fittings to the specified torque.



10012

IMPORTANT: Never apply more than 22.6 Nm (200 lb-in.) of torque to the steering hydraulic hose fittings.

Description	Nm	lb-in.	lb-ft
Steering hydraulic hose fittings	14.7	130	–

Filling and Purging the System

NOTE: Two technicians are required for the successful filling and purging of any system.

Twin Station or Twin Cylinder

⚠ WARNING

Improper venting of the hydraulic helm pump reservoir can cause fluid loss or introduce air into hydraulic system, resulting in insufficient hydraulic pressure for proper steering control. If installing more than one steering station, replace the vent/fill plug on all but the uppermost helm with a non-vent plug, included in a dual-station fitting kit.

For twin station or twin cylinder filling and purging (bleed) instructions, follow the instructions provided by SeaStar®. Refer to **Single Station with Single Cylinder** for instruction on how to fill and purge a single station with a single-cylinder system.

Single Station with Single Cylinder

Filling

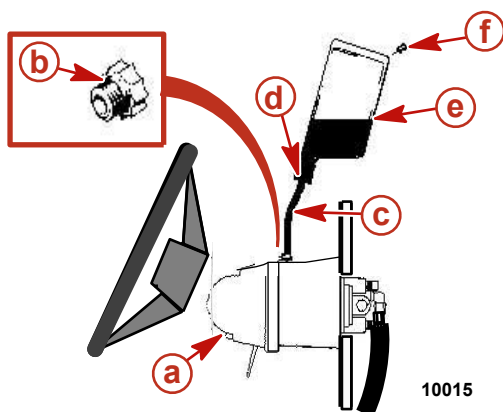
IMPORTANT: Hydraulic fluid must be visible in the filler tube during the entire filling procedure. Do not allow the bottle of fluid used for filling to empty, causing the filler tube to empty. This may introduce air into the system and require additional filling and purging.

Approximately 2 L (2 US qt) of approved hydraulic fluid are required for a single station with a single-cylinder system. The length of hydraulic hoses required will determine the amount.

1. Remove the vent/fill plug from the helm.
2. Use a filler kit (64-826525A1, ordered separately). Screw the filler tube into the vent/fill plug hole, and hand-tighten the filler tube.
3. Screw the bottle of hydraulic fluid into the cap end of the filler tube bottle. Turn the bottle upside down, and pierce the bottom of the bottle.

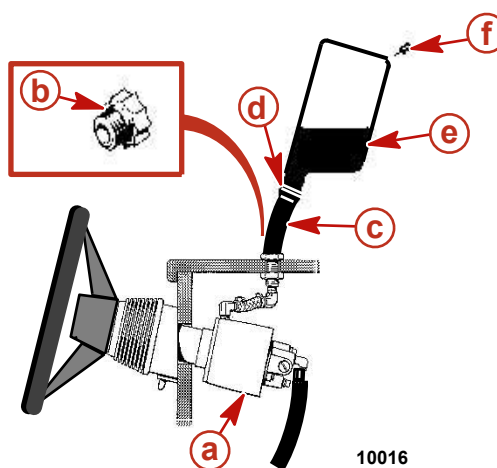
Description	Where used	Part Number
Hydraulic Helm Steering Fluid	Hydraulic steering system	92-862014Q1

4. Ensure that the hydraulic fluid is always visible in the filler tube while filling the helm pump. Install the next bottle while fluid is still visible in the filler tube but the first bottle is empty.
5. Before the bottle is completely empty and hydraulic fluid is still visible in the filler tube, quickly remove the first bottle and insert the second bottle. Thus, the filling process can be completed without introducing air into the system.
6. The helm is full when air bubbles no longer appear in the filler tube. Stop filling.



Standard helm

- a - Helm
- b - Vent fill plug
- c - Filler tube
- d - Bottle cap end
- e - Hydraulic fluid bottle
- f - Pin (to pierce bottle)



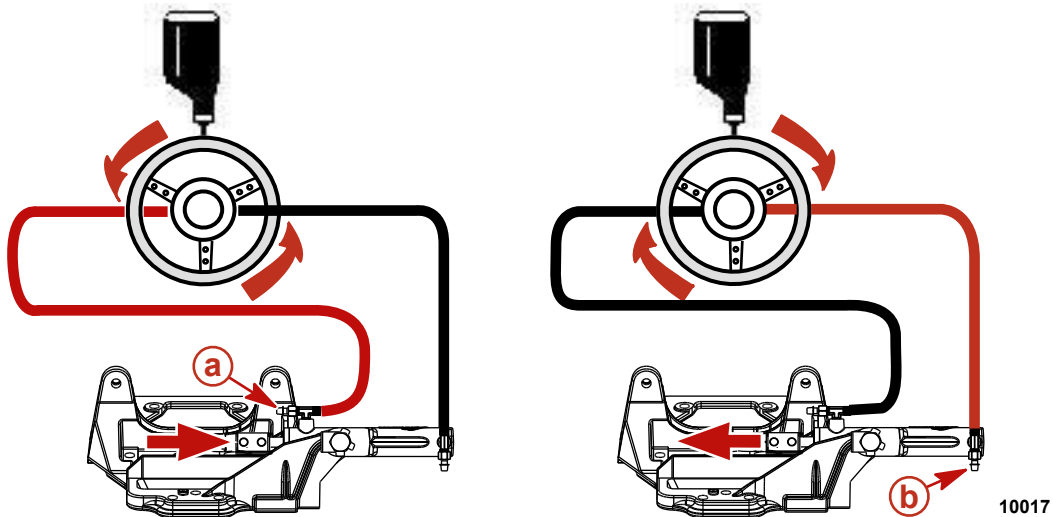
Sport helm

IMPORTANT: Do not proceed to the next step until the helm is full of hydraulic fluid. Ensure that air is not visible in the filler tube.

7. Leave a bottle of fluid inserted into the helm for use in purging the system of air.

Purging

NOTE: Turning the steering wheel in the direction shown moves the cylinder rod as indicated.

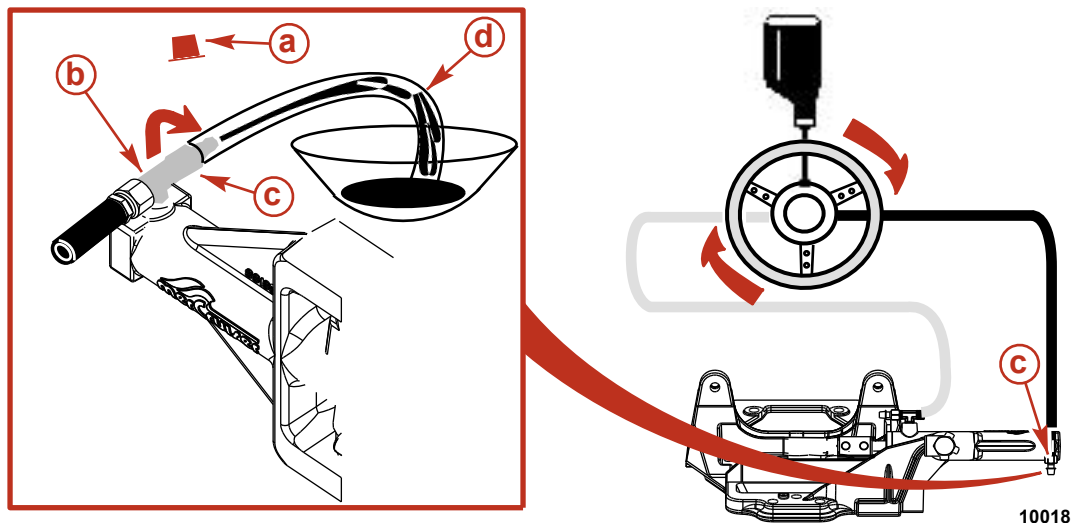


- a - Port bleeder valve
- b - Starboard bleeder valve

1. Remove the T-fitting bleeder valve caps on the cylinder assembly.

NOTE: Place temporary hoses (clear hoses are recommended) on the bleeder outlets and place these hoses in a container to avoid spills and air returning to bleeder.

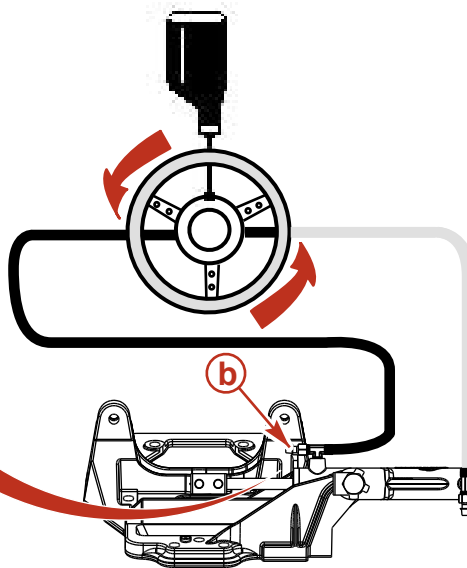
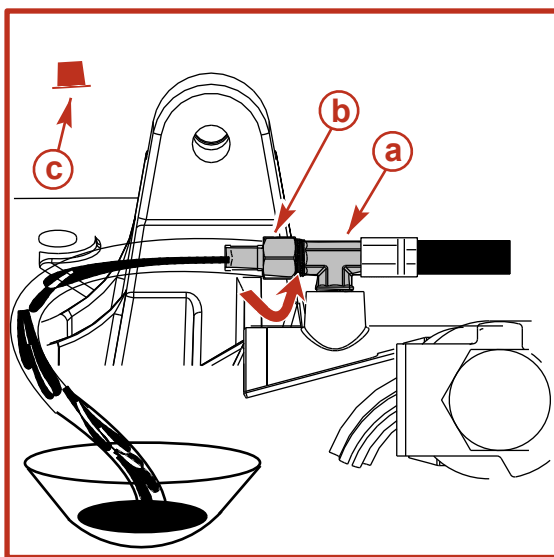
2. Turn the steering wheel slowly clockwise while an assistant opens the starboard bleeder valve.
3. Continue to turn the steering wheel clockwise until a solid stream of hydraulic fluid flows from the bleeder valve.



- a - Cap
- b - Starboard fitting
- c - Starboard bleeder valve
- d - Temporary hose (clear)

4. Close the starboard bleeder valve while continuing to turn the steering wheel.
5. Turn the steering wheel clockwise until the cylinder rod is fully extended. Ensure that the steering lever does not interfere with the cylinder clevis.

6. Turn the steering wheel slowly counterclockwise while an assistant opens the port bleeder valve on the steering cylinder.
7. Continue to turn the steering wheel until a solid stream of hydraulic fluid flows from the bleeder valve.
8. Close the port bleeder valve while continuing to turn the steering wheel.
9. Turn the steering wheel counterclockwise until the cylinder rod is fully retracted. The steering wheel will come to a stop.
10. Open the starboard bleeder valve.
11. Hold the cylinder rod to prevent it from extending. Turn the steering wheel counterclockwise until a solid stream of hydraulic fluid flows from the bleeder valve.
12. Close the bleeder valve while continuing to turn the steering wheel.
13. Filling and purging is complete. Refer to **Hydraulic Fluid Level** to adjust the fluid level and to check the system after **Connecting the Clevis**.



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- a** - Starboard T-fitting
- b** - Starboard bleeder valve
- c** - Cap

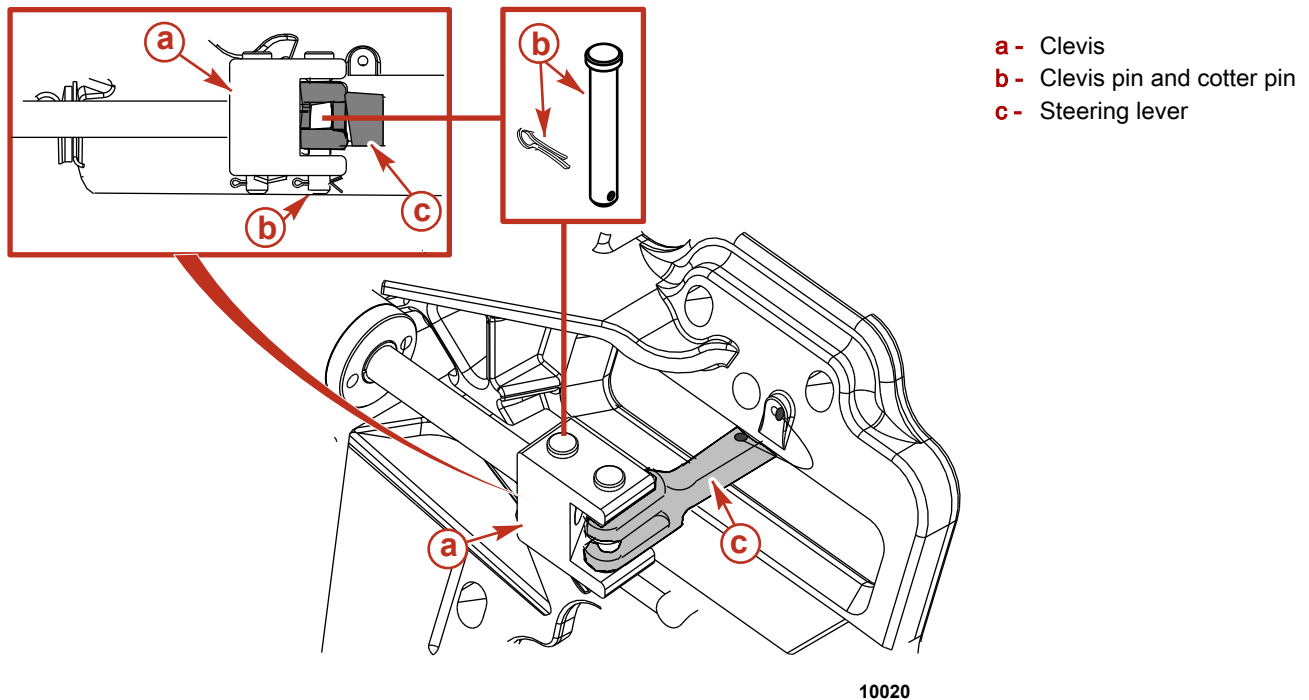
Connecting the Clevis

1. Lubricate the clevis pin and clevis.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with PTFE	Clevis pin and clevis	92-802859A 1

2. Connect the clevis to the steering lever. Spread both ends of the cotter pin.

IMPORTANT: Ensure that the clevis is positioned as shown below. The angled notch in the clevis must face the rear.



Hydraulic Fluid Level

⚠ WARNING

Failure to fill the system properly can damage steering components, causing serious injury or death from loss of boat control. Completely retract the cylinder rod before checking or adding hydraulic fluid.

Setting Fluid Level

The system must be filled and purged as outlined previously before setting the fluid level.

1. Ensure that the cylinder rod is fully retracted.
2. With the filler tube screwed into the helm filler plug hole, fill the tube approximately half full of air-free hydraulic fluid.
3. Open the starboard bleeder valve and slowly turn the steering wheel clockwise until the fluid level in the filler tube is at the top of the plastic filler fitting. Continue turning the steering wheel clockwise $\frac{1}{4}$ turn more, and then stop. Close the bleeder valve.
4. Remove the filler tube. The fluid level should be at the bottom of the filler hole. Install the vent/fill plug.

Maintaining Fluid Level

To maintain the proper fluid level, observe the following:

- Do not allow the fluid level to drop more than 6 mm ($\frac{1}{4}$ in.) below the bottom of the filler hole.
- Check the fluid level periodically.

System Check

After filling, purging, and setting the fluid level the system must be checked for proper connections, possible leaks, and complete purging of air.

IMPORTANT: In the following procedure, turn the wheel with enough force to exceed the pressure relief valve in the helm. This action should not harm the helm or the system.

1. Turn the steering wheel (any wheel on a multisteering station) hard to port to pressurize the system.
2. While maintaining system pressure, check all port fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before proceeding.
3. Turn steering wheel (any wheel on multisteering station) hard to starboard to pressurize system.
4. While maintaining system pressure, check all starboard fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before proceeding.

NOTE: A significant drop in fluid level at the helm while performing the system check may indicate there is air in the system. Further filling and purging is required.

5. If no leaks are present, the system is ready for service.

Maintenance

WARNING

Proper installation and maintenance is essential for the steering system to function. Use only the recommended hardware when installing the steering system. Follow all installation specifications and recommended maintenance procedures.

IMPORTANT: Loss of hydraulic fluid or hydraulic pressure may cause the steering system to malfunction. Ensure that the steering system maintains the proper level of hydraulic fluid.

NOTE: A damaged cylinder shaft can cause seal failure and leaks. Replacing seals on a damaged cylinder assembly will not stop leaks. A damaged cylinder shaft must be replaced immediately.

Task	Interval
Check the hydraulic fluid level in the helm pump.	Two times per year, or at the first indication that the steering system is not operating correctly, whichever occurs first.
Check for leaks.	
Check mechanical linkages and connections. Tighten loose parts and replace badly worn parts.	
Check the cylinder shaft for nicks and scratches.	

Troubleshooting Guide

Important Information

When troubleshooting requires component removal from the vessel or the dismantling of steering system components, this work must be carried out by a qualified marine mechanic. The following is offered as a guide only, and neither Mercury MerCruiser nor the helm manufacturer are responsible for any consequences resulting from incorrect repairs.

Most faults occur when the installation instructions are not followed and usually show up immediately upon filling the system. The following troubleshooting chart provides the most common faults encountered and their likely cause and solution.

Sometimes when returning the steering wheel from a hard-over position, a slight resistance may be felt and a clicking noise may be heard. This should not be mistaken as a fault, as it is a completely normal situation caused by the releasing of the lockspool in the system.

WARNING

Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

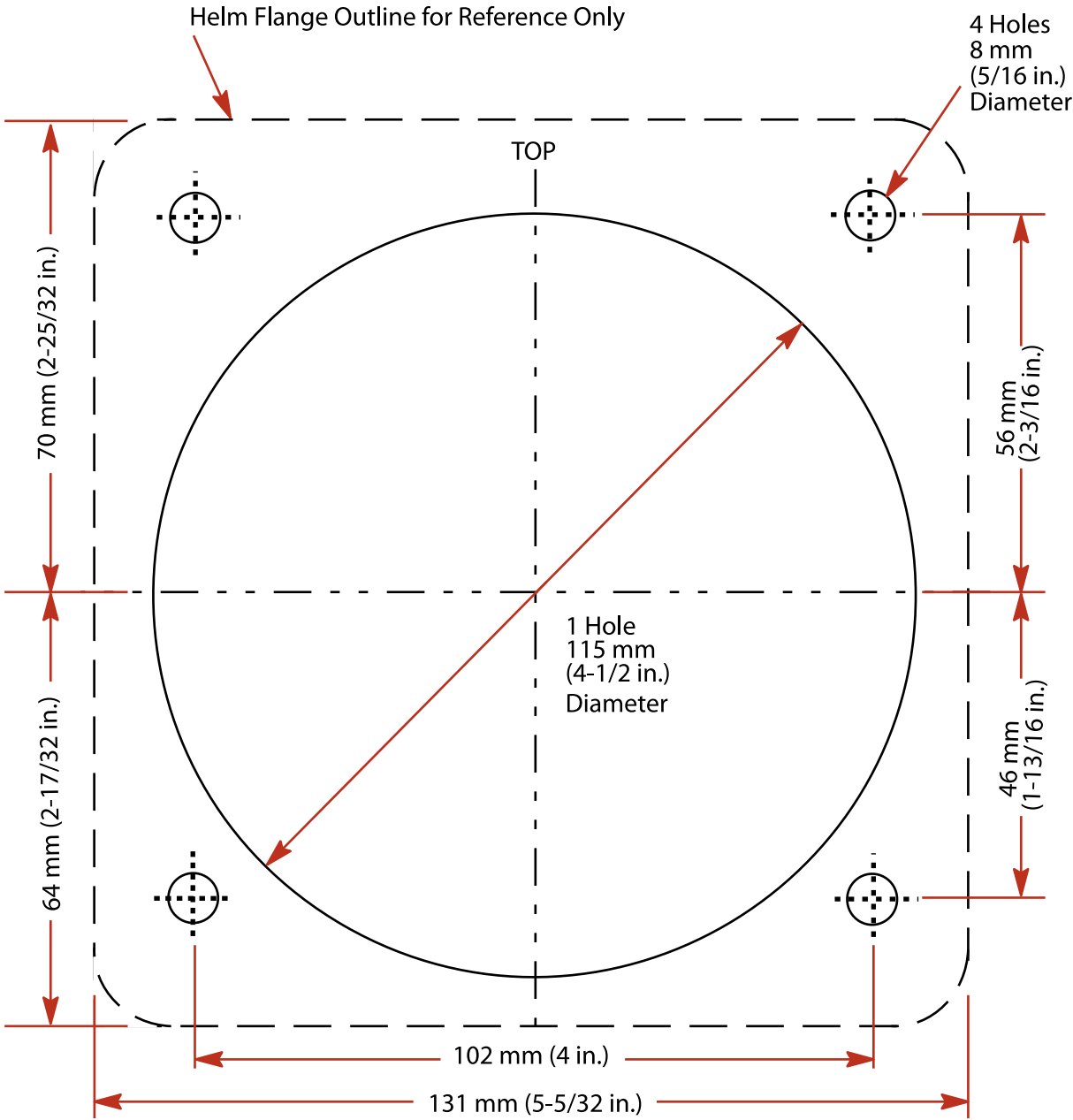
Troubleshooting Chart

Symptom	Cause	Solution
1. During filling, the helm becomes completely jammed.	Blockage in the line between the helms and the cylinders.	Ensure that hoses were not kinked or pinched during installation. If so, the hose must be removed and replaced.
2. System is difficult to fill. Air escapes from the top of the helm even after the system appears full.	Air in system.	Review filling instructions.

Compact Hydraulic Steering

Symptom	Cause	Solution
3. Steering is stiff and hard to turn, even when the vessel is not moving.	Steering cylinder pivot bushings are too tight or trunnion is bent, causing mechanical binding.	To test, disconnect the clevis from the steering lever and turn the steering wheel. If it does not turn easily, repair trunnion or loosen pivot bushings. Note that excessively loose connections to a steering cylinder or steering lever can also cause mechanical binding.
	Restrictions in hoses.	Find the restrictions and correct them.
	Air in hydraulic fluid.	Refer to the filling and purging instructions.
	The wrong hydraulic fluid has been used to fill steering system.	Drain the system and fill with approved hydraulic fluid.
4. The helm unit is bumpy and requires too many turns from port hard-over to starboard hard-over.	Dirt in inlet check valve of helm pump.	Replace the helm unit.
5. Steering is easy to turn while stationary, but becomes hard to turn when the vessel is underway.	Steering wheel is too small.	Fit a larger wheel, if possible. Refer to the installation instructions. If the problem cannot be rectified by changing the steering wheel, proceed with next cause and solution or consult the factory.
	Incorrect setting of trim tabs, if equipped.	Adjust tabs, if equipped.
6. Drive drifts to port or starboard while vessel is underway, even when the wheel is not being turned.	Dirt in check valves.	Remove the check valve plugs. These are the larger plugs on either side on rear of the helm. Clean the ball seats and balls, and reassemble.
7. Turning one steering wheel causes the second wheel to rotate.		NOTE: Be prepared to lose a certain amount of hydraulic fluid during this procedure. Have a small receptacle available. Refill the system when the check balls have been reassembled.
8. Seals will sometimes leak if steering system is not vented at uppermost helm.	The helm has a field-replaceable wheel shaft seal that can readily be replaced by removing the steering wheel and seal cover held in place by three small screws. Quad ring No. 210 is supplied in Seastar® Helm Seal Kit HS5151.	
9. Vent/fill plug leaks when turning to port.	Cylinder rod extended during filling.	Ensure that the cylinder rod is retracted during filling.

Standard Tilt-Helm Mounting Reference



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Notes: